

A380/A350
TECHNICAL TRAINING MANUAL
MAINTENANCE COURSES - NEW TECHNOLOGY COURSE
AIRBUS A380/A350 NEW TECHNOLOGY COURSE

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AIRBUS A380/A350 NEW TECHNOLOGY COURSE

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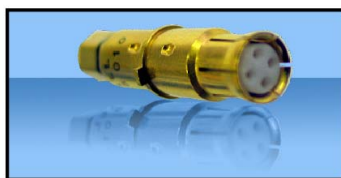
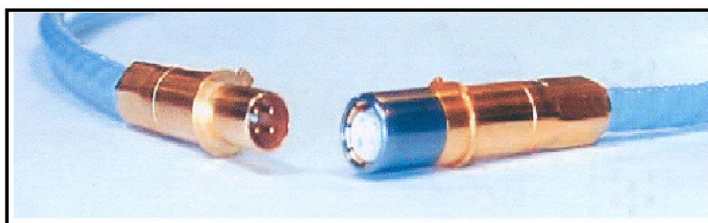
A380/A350 NEW TECHNOLOGIES OVERVIEW

Aluminum Cables and Quad Cables

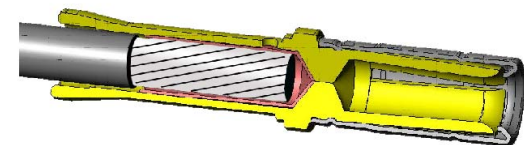
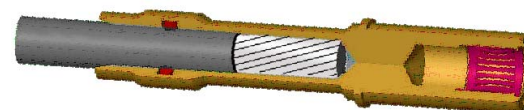
New technologies related to the wiring are used on the A380 and A350:

- Aluminum cables and related contacts (for a lower total weight of the aircraft)
- Quad cables and quadrax contacts, used in new types of network.

QUAD CABLES AND QUADRAX CONTACTS



ALUMINUM CABLES & CONTACTS



ALUMINUM CABLES AND QUAD CABLES

A380/A350 NEW TECHNOLOGIES OVERVIEW

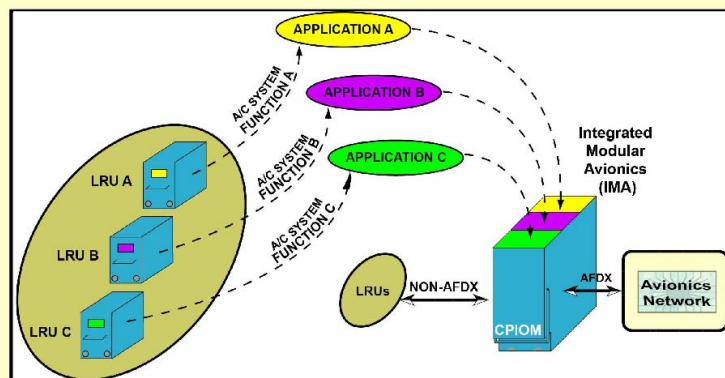
Avionics Evolutions

About the Avionics systems, the new generation of Airbus aircraft

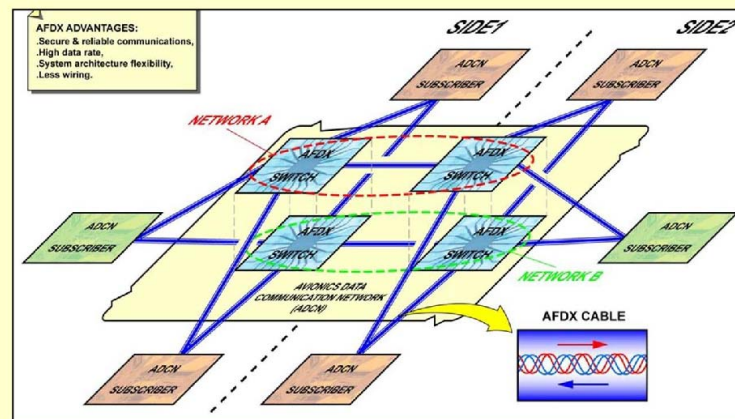
Avionics includes now:

- New types of computers (IMA, Servers, cabinets)
- New types of high-speed networks (AFDX Network, ADCN)
- Software components and related operations that are used in many systems.

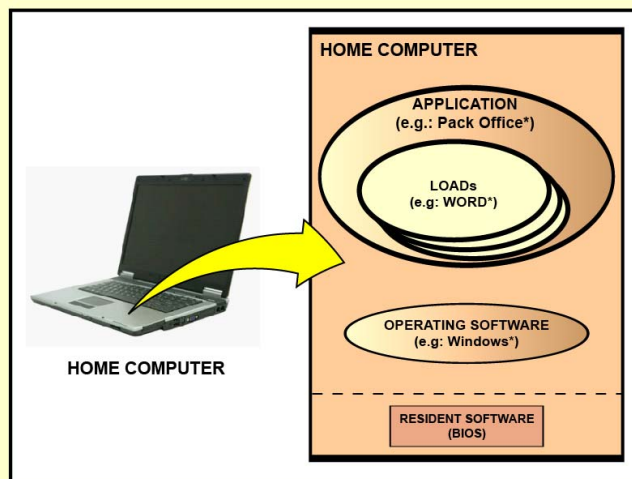
COMPUTERS EVOLUTION



AFDX NETWORK/ ADCN



SOFTWARE OPERATIONS



AVIONICS EVOLUTIONS

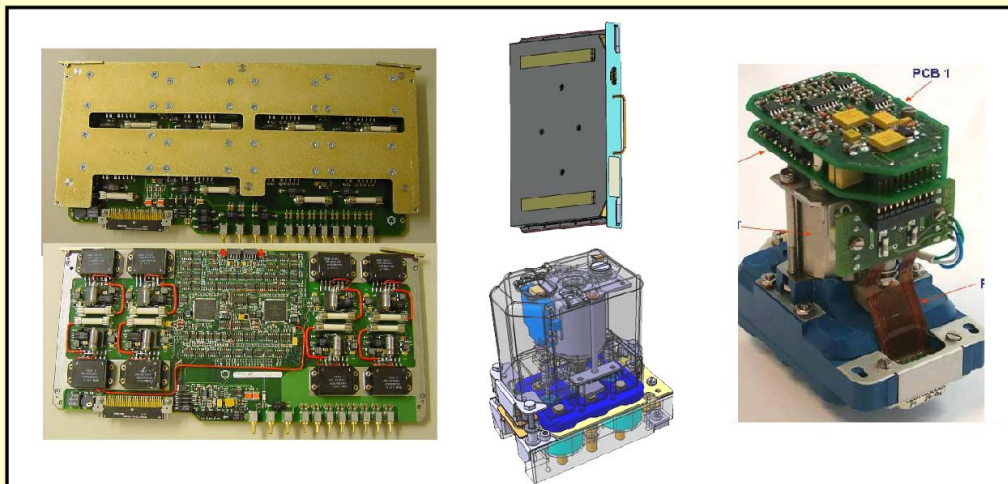
A380/A350 NEW TECHNOLOGIES OVERVIEW

New Contactors / Lights / Wireless Communications

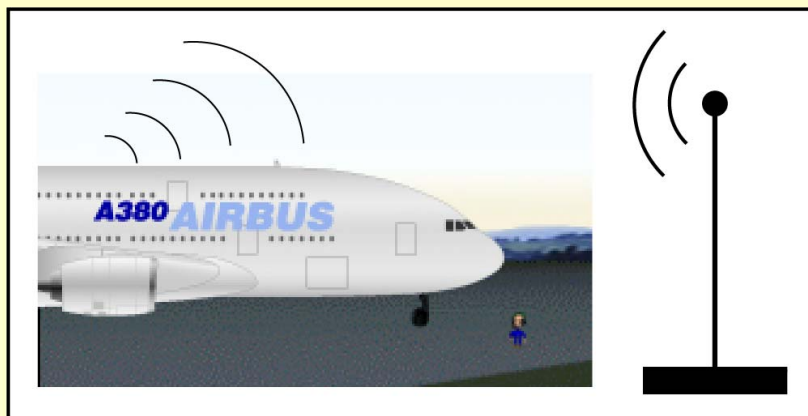
The A380 and A350 also have:

- New types of electrical contactors (Solid State Power Controller (SSPC) modules, Programmable Remote Control Circuit Breakers (RCCBs))
- Light Emitting Diode (LED) and High Intensity Discharge (HID) lighting, used in many systems
- Wireless communication systems, usually used for Airline Operational Control (AOC) communications on ground.

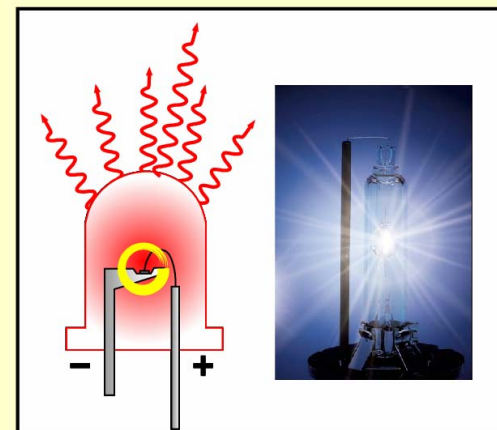
NEW ELECTRICAL CONTACTORS



WIRELESS COMMUNICATIONS



LED / HID LIGHTS



NEW CONTACTORS / LIGHTS / WIRELESS COMMUNICATIONS

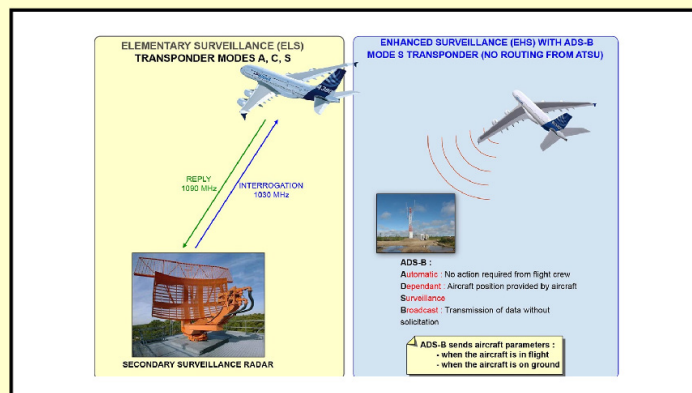
A380/A350 NEW TECHNOLOGIES OVERVIEW

Air Traffic Control Means / Landing Systems

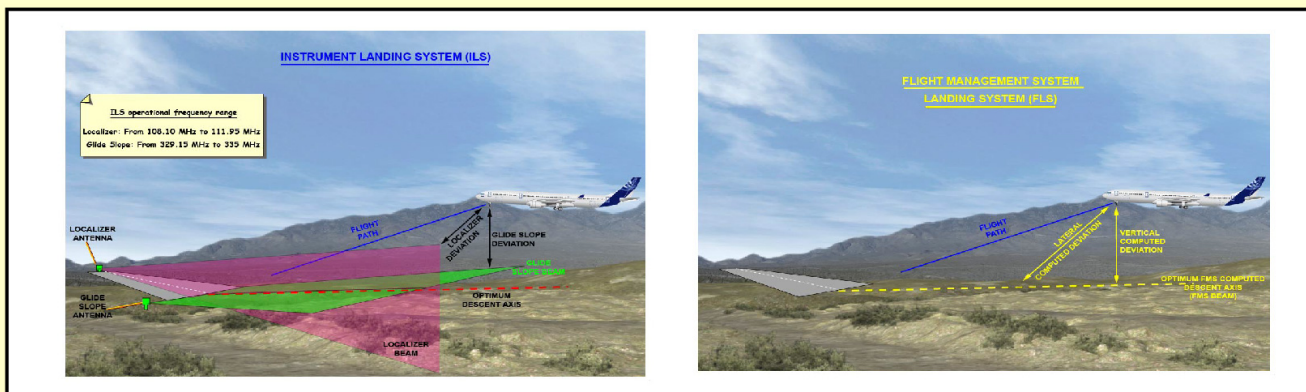
New air traffic control means such as ADS-B IN /OUT enable to improve air traffic management and surveillance.

In addition, landing systems will be also further described in this course, and in particular new landing systems such as GLS (GBAS Landing Systems) and SLS (SBAS Landing Systems).

AIR TRAFFIC CONTROL MEANS



LANDING SYSTEMS



AIR TRAFFIC CONTROL MEANS / LANDING SYSTEMS

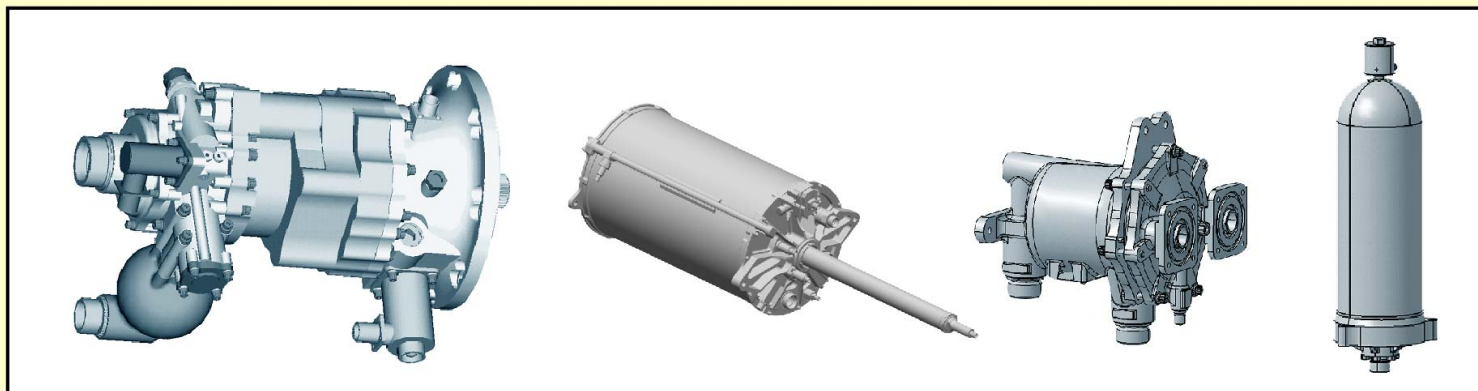
A380/A350 NEW TECHNOLOGIES OVERVIEW

Electro-Hydraulic Components Evolutions

The A380 and A350 use 5080 PSI high-pressure hydraulic circuits and components (for a lower total weight of the aircraft).

These aircraft also use a new generation of electro-hydraulic components: Electro-Hydrostatic Actuator (EHA), Electrical Backup Hydraulic Actuator (EBHA), Local Electro-Hydraulic Generation System (LEHGS)...

5080 PSI HYDRAULIC COMPONENTS



NEW ELECTRO-HYDRAULIC COMPONENTS



ELECTRO-HYDRAULIC COMPONENTS EVOLUTIONS

A380/A350 NEW TECHNOLOGIES OVERVIEW

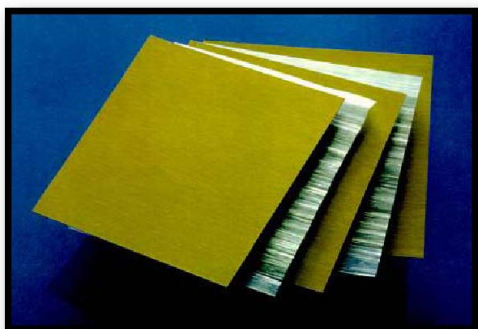
A380 Structure

The A380 structure includes a new type of composite material: the GLARE material.

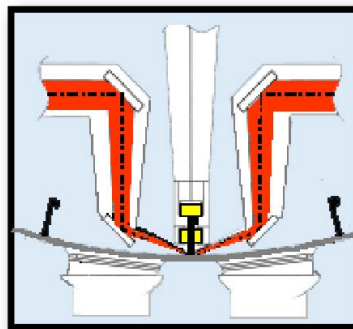
New manufacturing methods are also used for a better manufacturing of the aircraft:

- Laser beam welding
- High Velocity Oxygen Fuel.

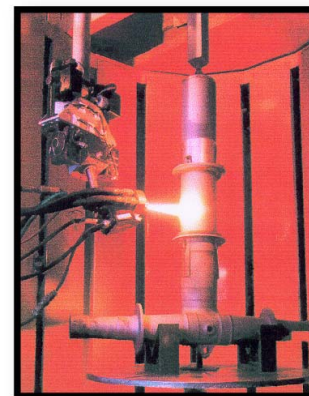
A380 STRUCTURE



GLARE



LASER BEAM WELDING



**HIGH VELOCITY
OXYGEN FUEL**

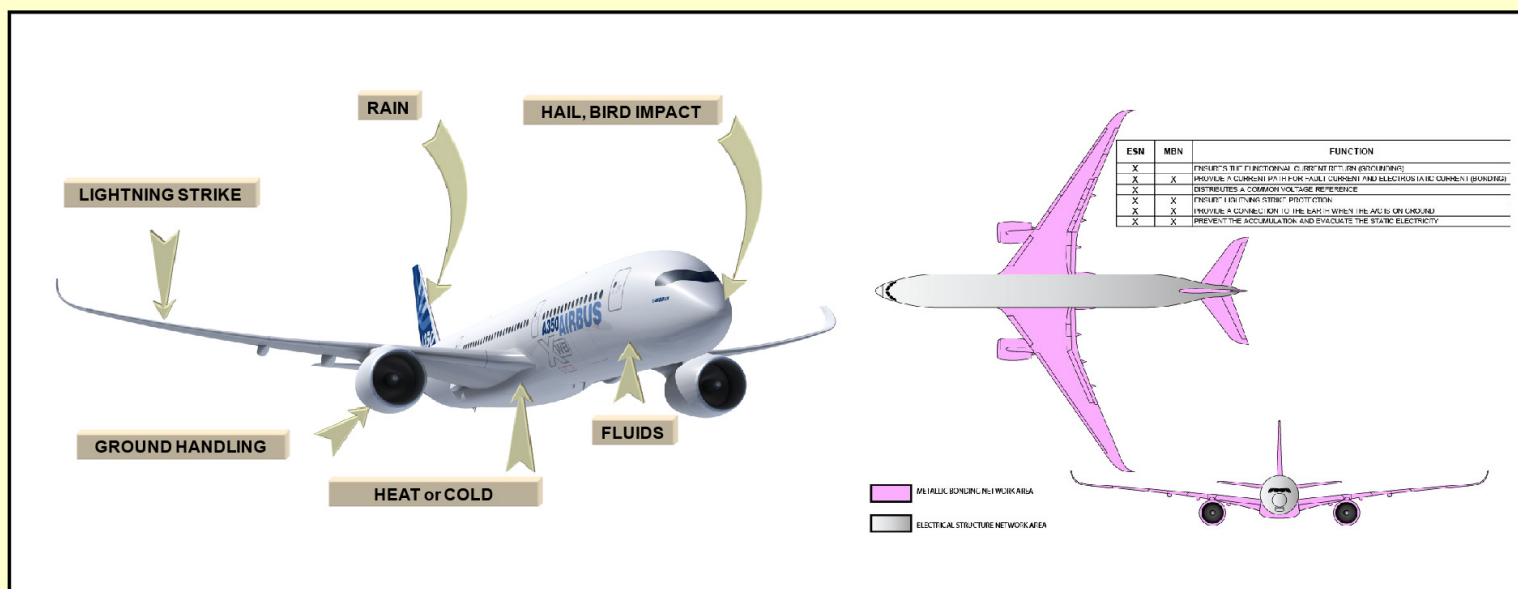
A380 STRUCTURE

A380/A350 NEW TECHNOLOGIES OVERVIEW

A350 Structure

The A350 structure is made of an intensive use of composite material. Due to this major innovation it is necessary to insist on associated composite awareness. The course will also introduce the new Electrical Structural Network (ESN) necessary for current return for example on the aircraft.

A350 STRUCTURE



A350 STRUCTURE

ALUMINUM CABLE PRESENTATION

Reasons for Introduction of Aluminum Wires

Large commercial aircraft use more than 300 km of electrical wires with a total weight of approximately 1.8 tons.

For an average wire gauge, the wire weight comes approximately 80% from the conductor material and 20% from the insulation.

The Insulation weight was already decreased by 25% compared to the first generation of Airbus aircraft. More reductions are not possible because of strict safety requirements, especially related to the resistance against arc tracking.

The weight of the conductor is related to the wire gauge and the material. Copper is usually recommended as a conductor material, because it has a very low resistance.

Aluminum has only approximately 30% of the specific gravity of copper, but approximately 60% more electric resistance.

To keep the wire resistance of an aluminum wire the same as a copper wire, it is necessary to increase the section area of the aluminum wire by approximately 60%.

With this larger cross-section, you will only get a weight reduction of approximately 50% for heavy wires for generator feeder lines and heavy loads.

This weight saving is already done on present aircraft types and has a maximum value of 200 kg.

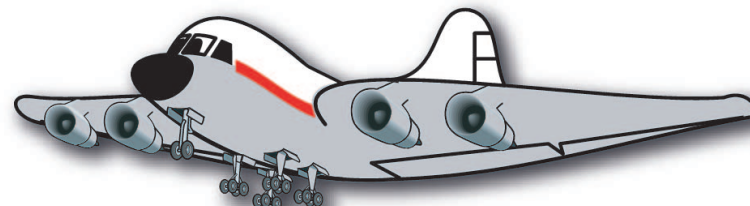
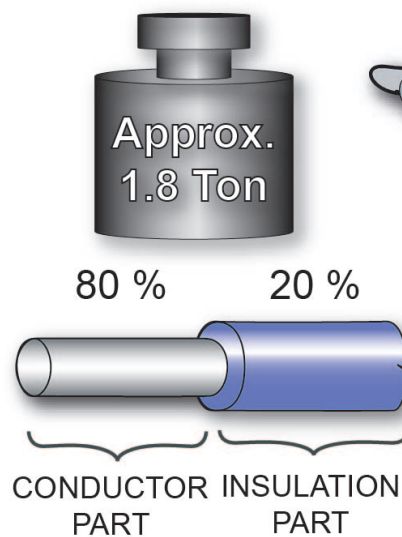
But approximately 98% of the aircraft wires have the smaller cross-sections of wire gauges 04 to 24. Until now, their conductor part was always made of copper.

On the A380 and A350, for the first time, almost all copper wires are replaced by aluminum wires, to get additional weight saving. The weight reduction for the smaller wire gauges is only approximately 20%.

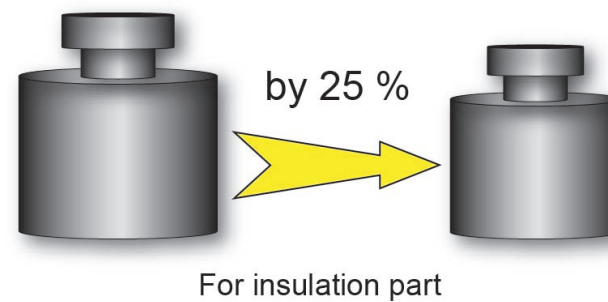
Insulation part can also be optimized, thus leading to an additional weight reduction of approximately 300kg.



Kilometers (~ 300 Km)

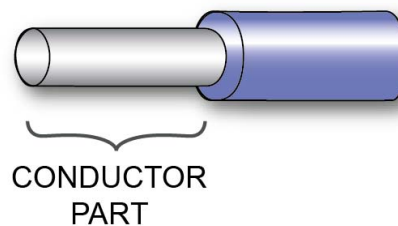


More reductions of weight are not possible since it would result in insufficient insulation part.

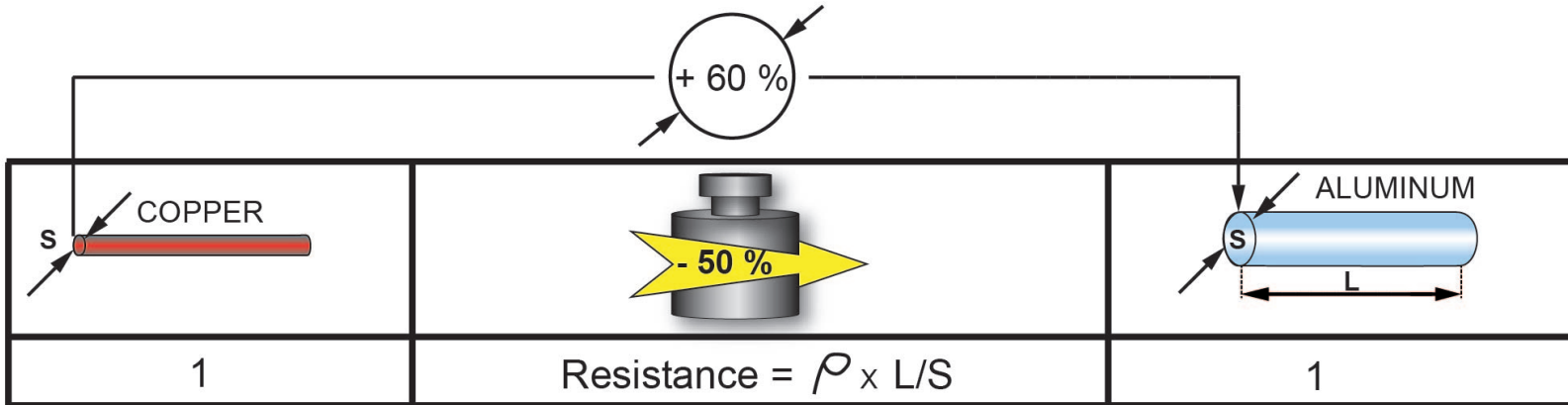


REASONS FOR INTRODUCTION OF ALUMINUM WIRES

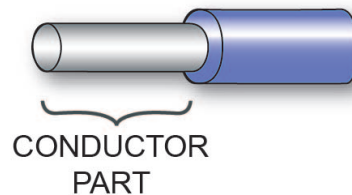
 COPPER	Properties	 ALUMINUM
1	 Specific Gravity	0'3
(very low) 1	Resistance	1'6



REASONS FOR INTRODUCTION OF ALUMINUM WIRES



Resistivity: ρ
Copper $\rho: 1,7 \cdot 10^{-8} \Omega \cdot m$
Aluminum $\rho: 2,7 \cdot 10^{-8} \Omega \cdot m$



For generator feeder lines
and heavy loads



98% Copper



Aluminum Wire Gauges 04 to 24

Weight Reduction 20 %



REASONS FOR INTRODUCTION OF ALUMINUM WIRES

ALUMINUM CABLE PRESENTATION

Disadvantages of Aluminum Wires

Aluminum has some disadvantages compared to copper: The first one is caused by the lower conductivity of aluminum.

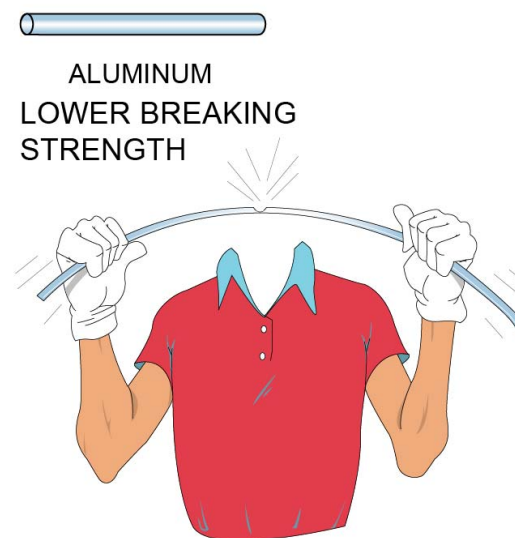
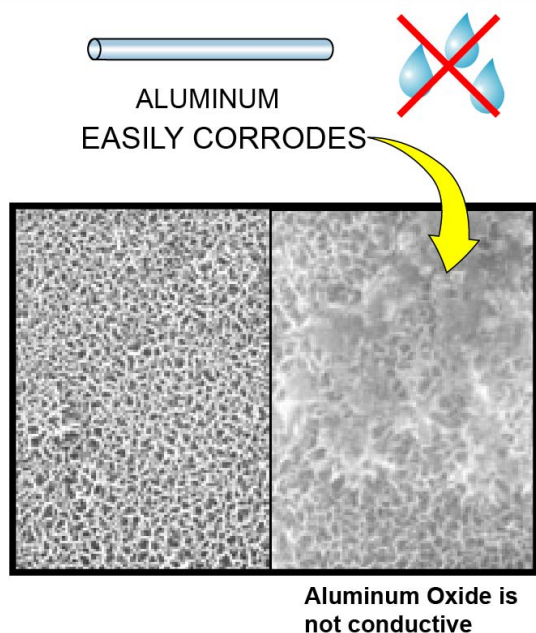
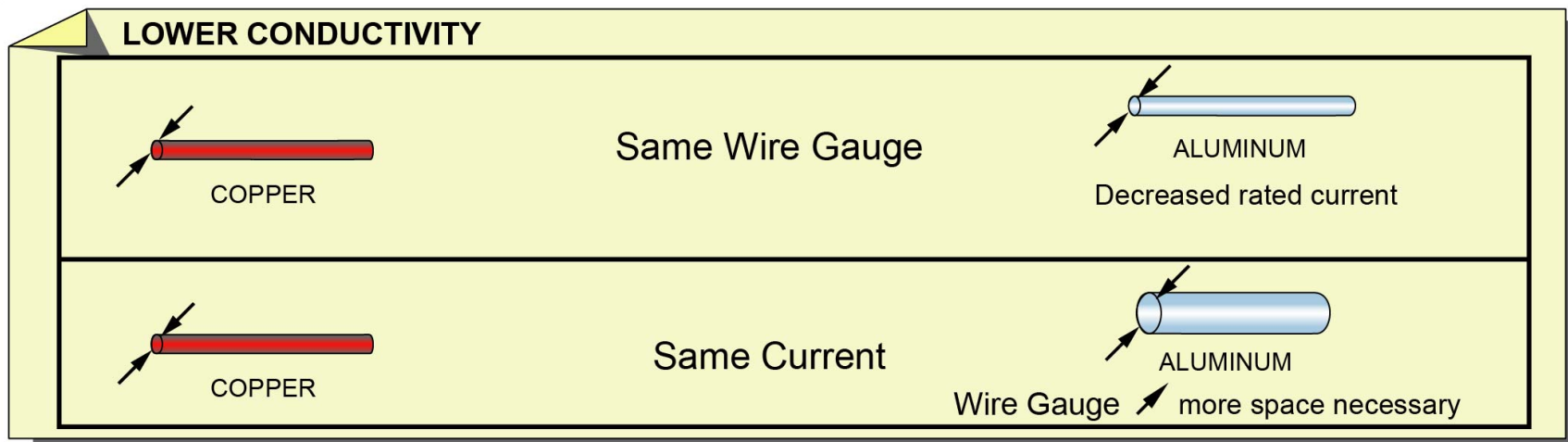
If the wire gauge is the same for these two materials, the rated current must be decreased.

If the rated current must be kept, a larger section of the wire will be necessary, which gives a space penalty.

The second disadvantage is that Aluminum corrodes easily and that the aluminum oxide is not conductive. Thus, aluminum material must never come in contact with humidity.

The third disadvantage is the lower breaking strength of pure Aluminum compared to copper. You must be careful about this for the wire, contact and splice construction and you must strictly obey the installation procedures.

To prevent problems with aluminum wires, specific procedures must be obeyed and special components and tools must be used.



DISADVANTAGES OF ALUMINUM WIRES

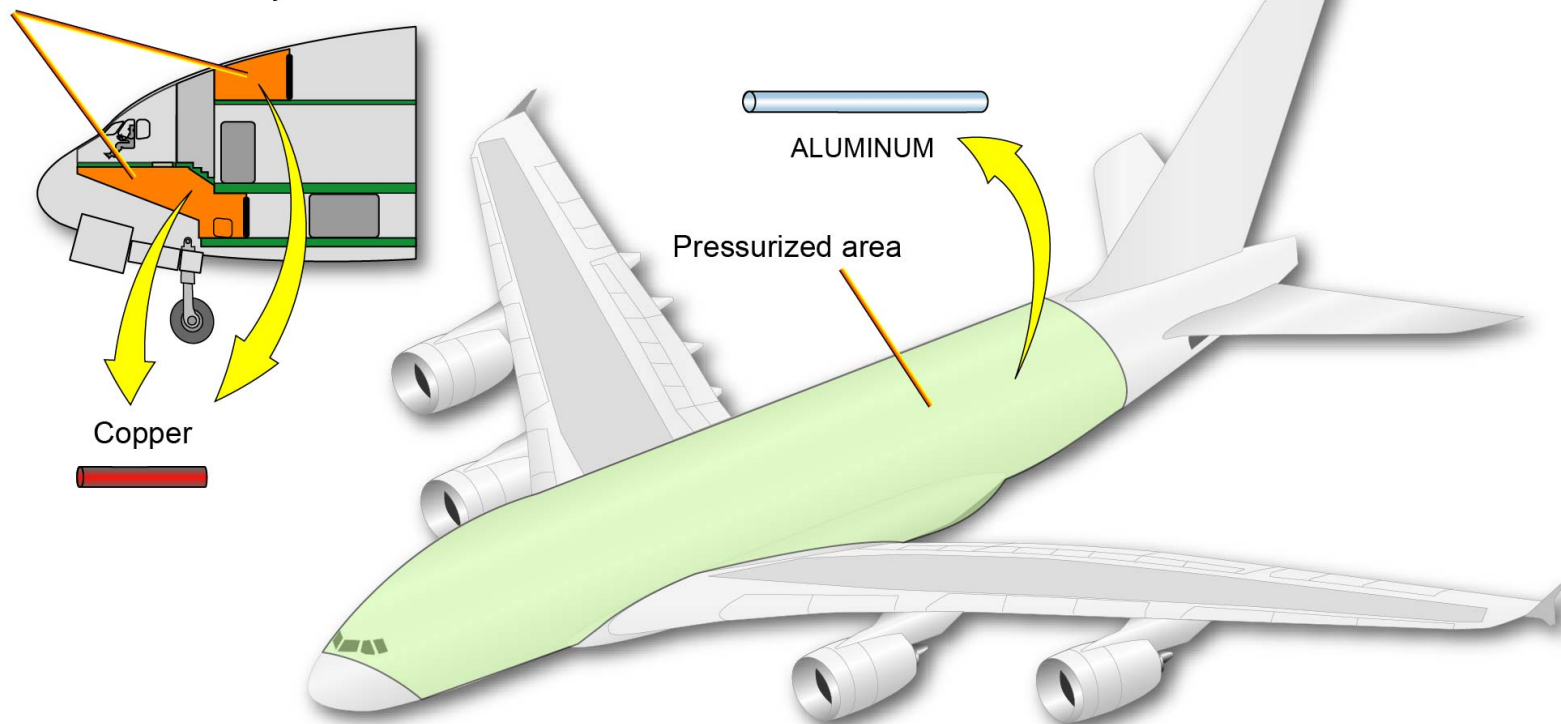
ALUMINUM CABLE PRESENTATION

Application of Aluminum Wires in the A380

In the pressurized areas of the A380 and A350, it is generally approved to use aluminum wires, but they are not used in VU panels primarily installed in avionics bays because of a small benefit of weight saving. There is also a high bending radius applied to the VU wires (BF type wires are used).

In the unpressurized areas of the aircraft with high environmental risks like vibrations and humidity, only large wire gauges from 10 to 000 are made of aluminum.

VU PANELS in Avionics Bays



UNPRESSURIZED AREAS :

Wire Gauge 10 to 000 : Aluminum

Wire Gauge 24 to 12 : Copper



Humidity
and Vibrations

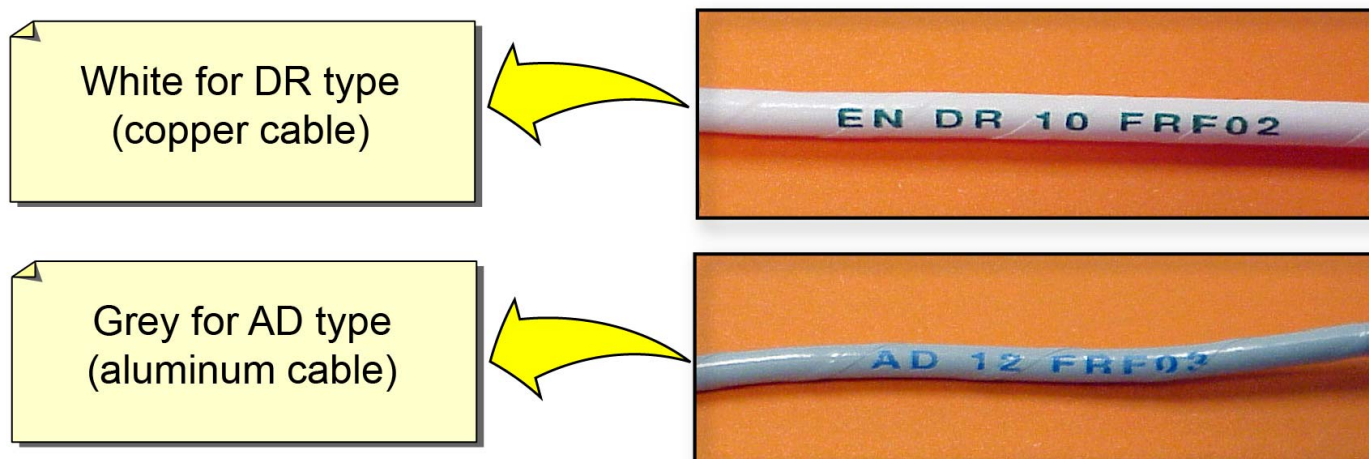
APPLICATION OF ALUMINUM WIRES IN THE A380

ALUMINUM CABLE: MATERIALS AND TOOLS

Wire Insulation Colors

The color of the copper wire insulation is usually white.

The color of the aluminum wire insulation is grey.



WIRE INSULATION COLORS

ALUMINUM CABLE: MATERIALS AND TOOLS

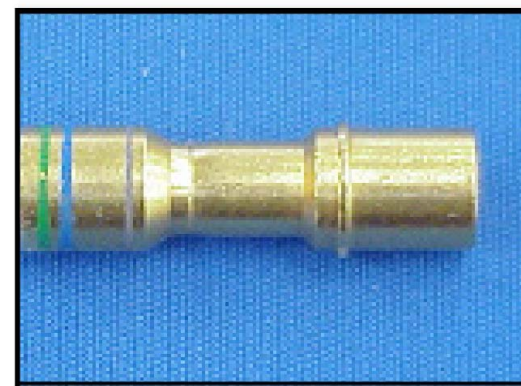
Construction of Contacts for Aluminum Wires

Special contacts must be used for the new aluminum wires. They are designed to prevent contact of humidity with the aluminum core. Two different types are available in relation to the size of the wire gauge. One is used for Wire Gauges 24 to 12 and the second one for wire gauges 10 to 04.

**CONTACTS FOR
WIRE GAUGES 24-12**



**CONTACTS FOR
WIRE GAUGES 10-04**



CONSTRUCTION OF CONTACTS FOR ALUMINUM WIRES

ALUMINUM CABLE: MATERIALS AND TOOLS

Construction of Contacts for Aluminum Wires (continued)

Contacts for AWG 24 to 12

The contacts for aluminum Wire Gauges 24 to 12 have a special crimping area for the wire insulation, to make sure the sealing is correct.

The electrical crimping gives the usual perfect conductivity between the core and the contact body.

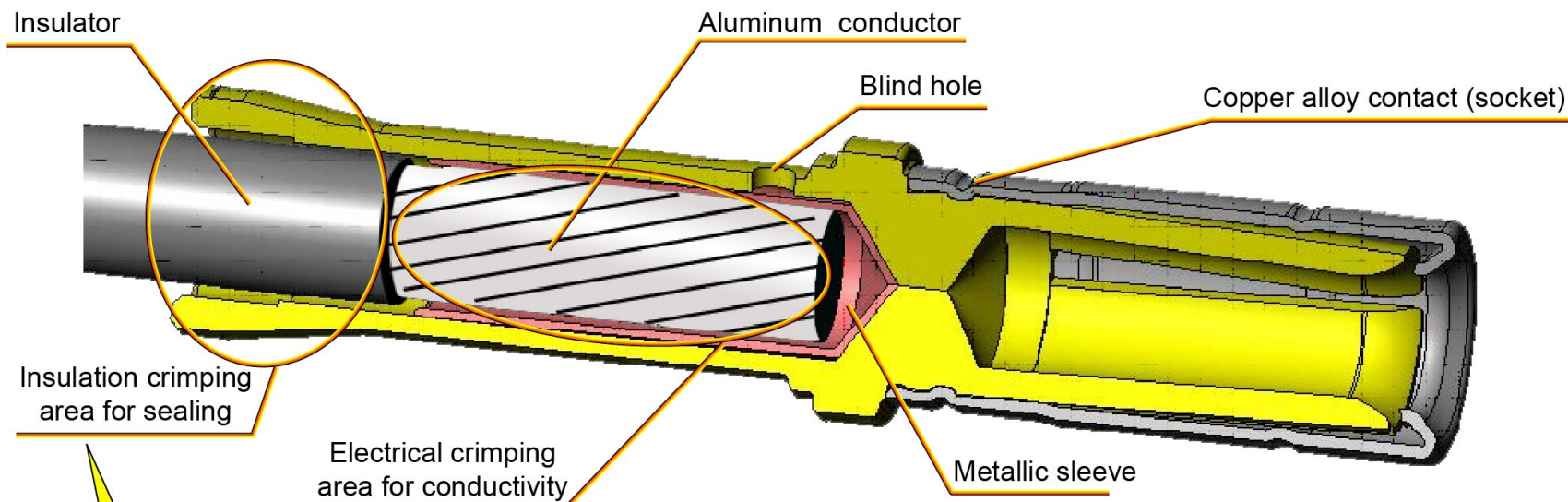
A metallic sleeve divides the different materials, gives a better conductivity and seals the initial blind hole which was used for the manufacturing of the contact. Here is a cut view with all components of the electrical crimping area, contact body, conductor strands and metallic sleeve.

The crimping of the insulation seals the contacts. The insulation gives more breaking strength and more stability to the wire.

An accurate double crimping is mandatory to get a correct electrical connection and a stable wire installation.

Special crimping tools are necessary for the double crimping. Crimping tools for aluminum wires are identified with the purple color.

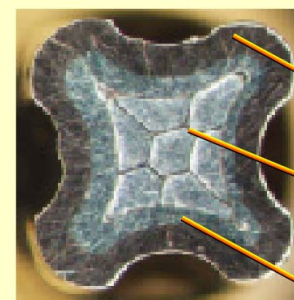
CONTACT FOR ALUMINUM WIRES WITH WG 24 TO 12



**Double crimping
with new tools**



ELECTRICAL CRIMPING AREA



Contact body

Conductor strands

Metallic sleeve

CONSTRUCTION OF CONTACTS FOR ALUMINUM WIRES - CONTACTS FOR AWG 24 TO 12

ALUMINUM CABLE: MATERIALS AND TOOLS

Construction of Contacts for Aluminum Wires (continued)

Contacts for AWG 10 to 04

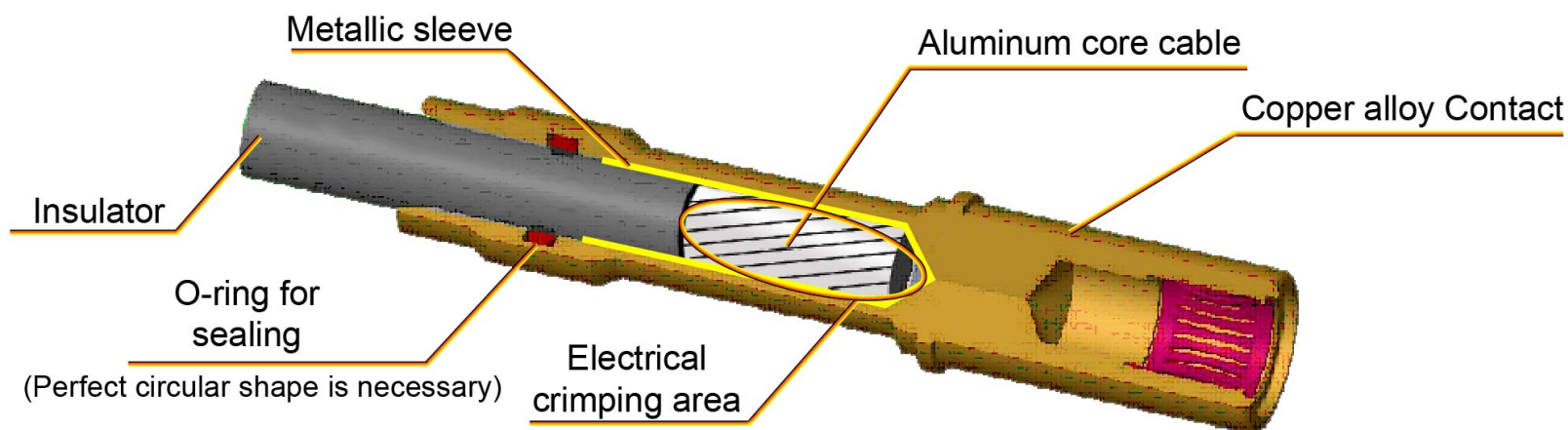
For Wire Gauges 10 to 04, a double crimping is not necessary.

For these gauges, the insulation is not crimped, but an O-ring is installed in the contact to make the sealing to the wire insulation.

A perfect circular shape of the wire is necessary to get a 100% sealing by the O-ring.

The electrical crimping gives the perfect conductivity between the wire core and the contact body, helped by the metallic sleeve. A power tool with pneumatic or hydraulic support is necessary to get sufficient force for the electric crimping of the large wire gauges.

CONTACTS FOR ALUMINUM WIRES WITH WG 10 TO 04



POWER TOOL FOR ELECTRICAL CRIMPING

CONSTRUCTION OF CONTACTS FOR ALUMINUM WIRES - CONTACTS FOR AWG 10 TO 04

ALUMINUM CABLE: MATERIALS AND TOOLS

Cutting

Aluminum wires must be cut with special tools to make sure that the cable is not crushed during the operation. Conventional cutters can cause an oval cross section during the cut.

Ideal T-cutter 45-074 and Weidmüller KT8/900265 cutting tools do not flatten the cable and it is recommended to use them.

If these tools are not available, Ideal T-cutter 45-260 or 45-123 can be used. These tools have a knife with a special shape that lets the wire shape be kept circular during the cut and the cut surface be straight and perpendicular to the wire. This is important for a good sealing of the crimped connection.

Before the stripping of wire sizes 10 to 04, a geometrical reconfiguration of the cylindrical shape of the conductor part can be necessary. To do this, use Labinal D22-002-000 reshaping tool or equivalent. AD wire sizes 10 to 04 must have a perfect circular shape because they are sealed by an O-ring in the contact

Note: If an Aluminum wire was stored, it must be cut at 30 mm minimum from the end to remove the conductor end exposed to atmospheric contamination.

NO
OVAL CROSS
SECTION



RECOMMENDED CUTTER TOOLS

IDEAL T-cutter 45-074



Weidmüller KT8/900265



IDEAL T-cutter N°45-260



IDEAL T-cutter N°45-123



Reshaping Tool
Labinal D22-002-000



If reshaping is
necessary for
sizes 10 to 04

Aluminum wire that was stored,
must be cut at 30 mm minimum

CUTTING

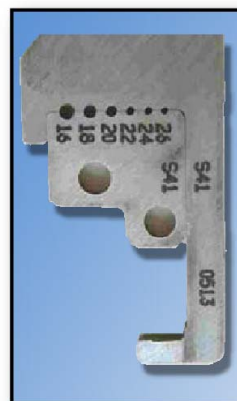
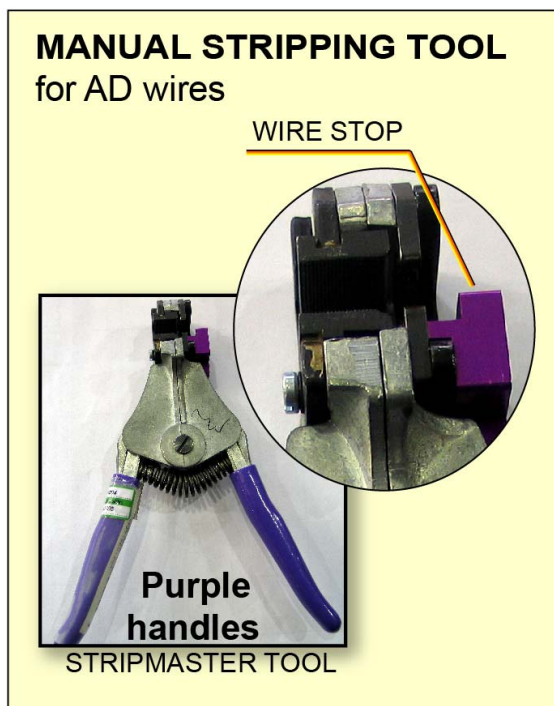
ALUMINUM CABLE: MATERIALS AND TOOLS

Stripping of AD Cables WG 24 to 10

Manual tools used to strip AD wires with gauges from 24 to 10 are STRIPMASTER type and can be easily identified by their purple handles. This tool does a very accurate stripping, which prevents damage to the nickel plating, and it has a wire stop to get the correct stripping length. This wire stop is mandatory to strip aluminum wires.

Two different stripper tools are available from each supplier, one with stripping dies blade for 16 to 24 gauges and one with stripping dies blade for 10 to 14 gauges.

Note: These stripping dies blades can also be used for the DR type copper wires, thus you can also find a die for wire gauge 26, which is not used for aluminum wires.



STRIPPING DIES BLADE
FOR WG 16 TO 24



STRIPPING DIES BLADE
FOR WG 10 TO 14

Same blades are also used to strip DR type wires



The Stripped cable end
must be immediately connected



STRIPPING OF AD CABLES WG 24 TO 10

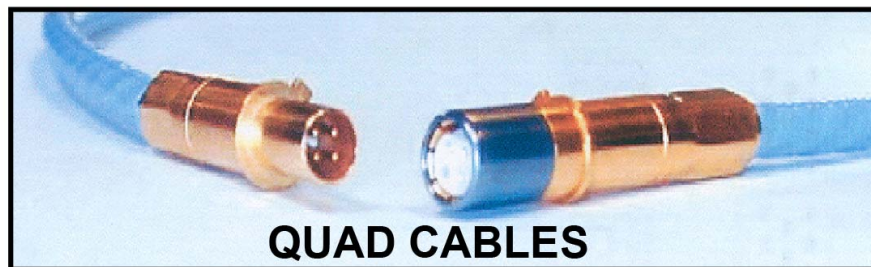
QUAD CABLE AND QUADRAX CONTACT PRESENTATION

Function of Quad Cables

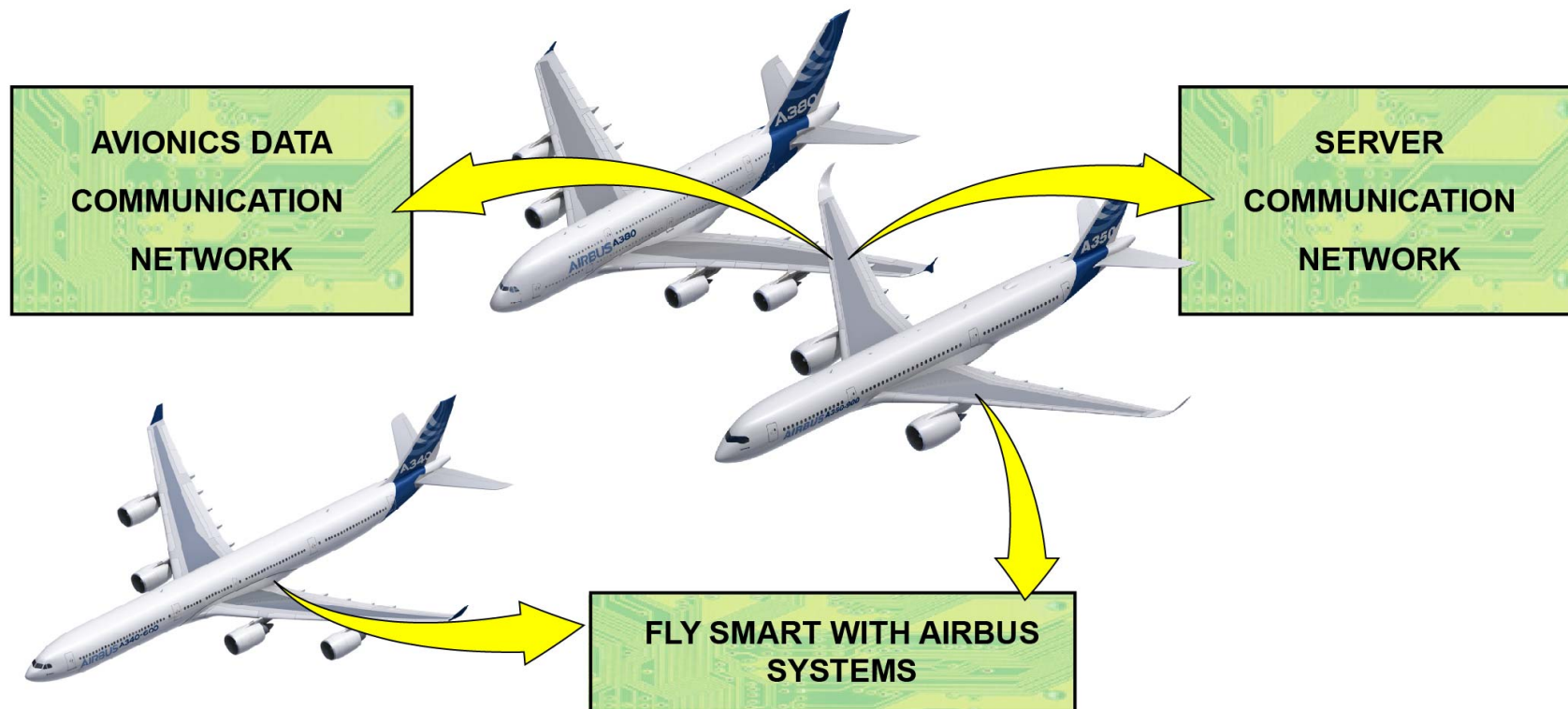
Quad cables are used in modern commercial aircraft to transmit high-speed Ethernet or AFDX data.

Ethernet or AFDX data communication is used on the A380 and A350 in the avionics data communication and server communication networks.

Quad cables are also found in the cabin data communication and entertainment systems, for example, in the Fly Smart with Airbus systems of the A340-500/600 and A350.



Used in :



FUNCTION OF QUAD CABLES

QUAD CABLE AND QUADRAX CONTACT PRESENTATION

Quadrax Harnesses for Full Duplex Operation

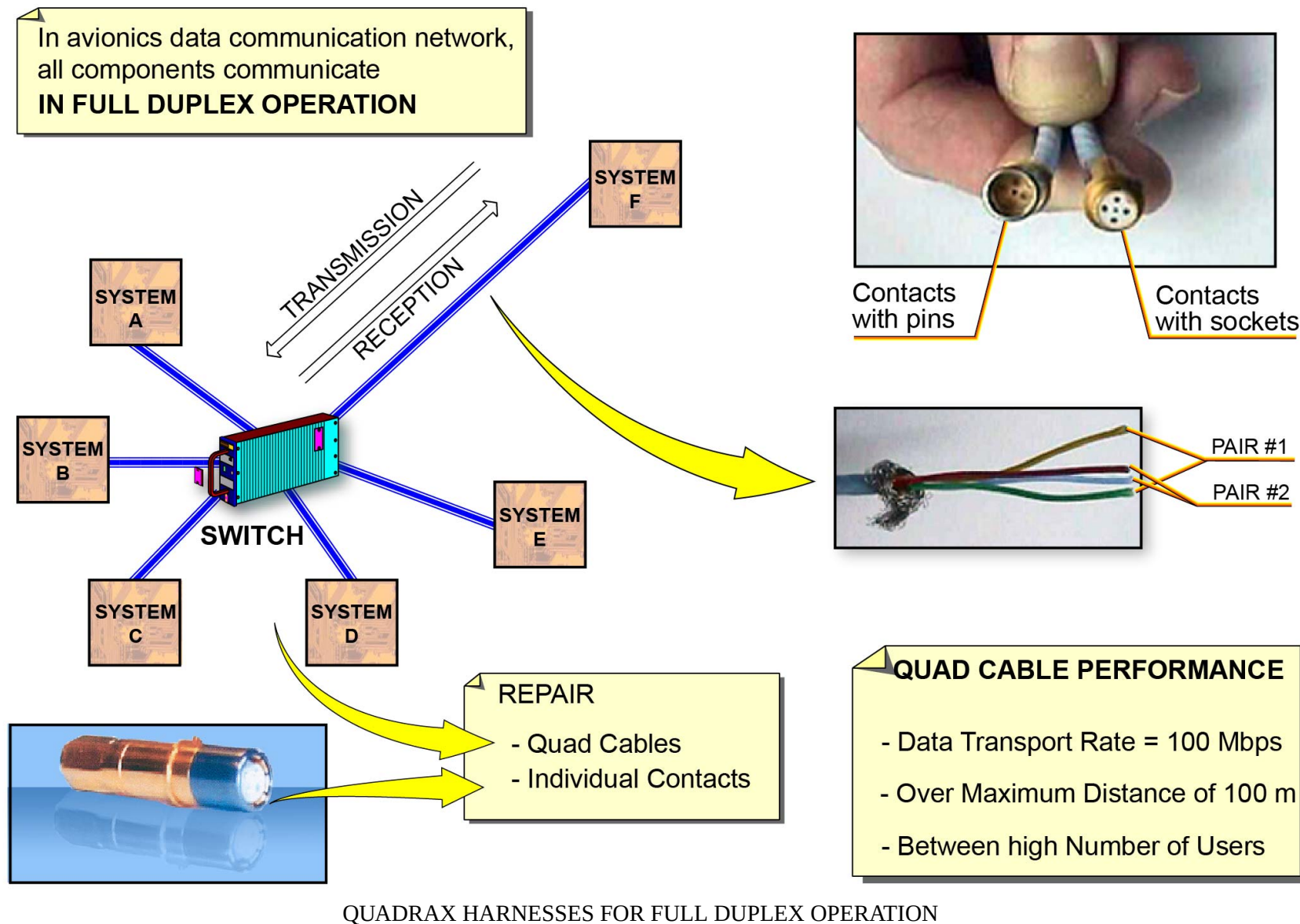
In the avionics data communication network, all components communicate in a full duplex operation, because two wires of quad cable transmit the data in one direction (transmission) and the other two wires transmit the data in the opposite direction (reception).

Quad cables are usually delivered as complete harnesses.

One harness has a shielded quad cable with four internal copper wires and a contact on each end.

The contact has pins or sockets.

In the Ethernet Network, the quad cables guarantee data transmission without failure to a maximum of 100 Mega bits per second over a maximum distance of 100 meters between a very high numbers of users.



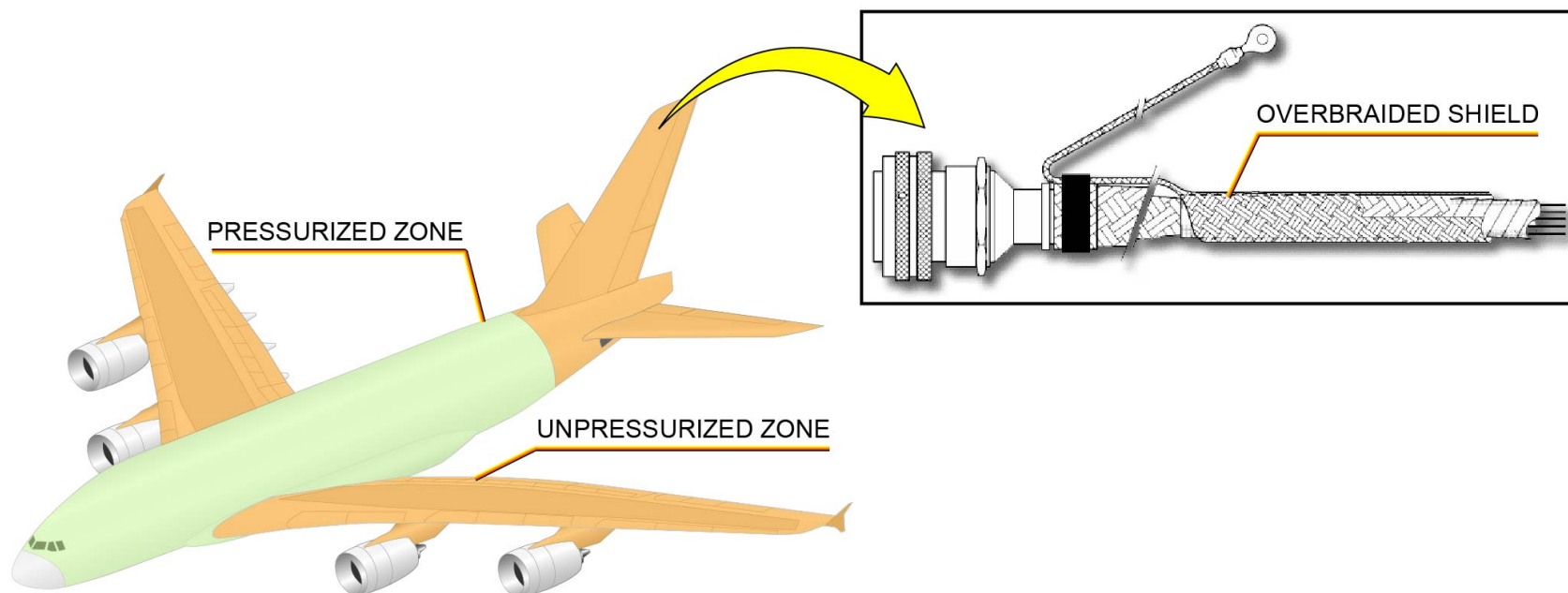
QUADRAX HARNESSES FOR FULL DUPLEX OPERATION

QUAD CABLE AND QUADRAX CONTACT PRESENTATION

Application

Most Quad cable harnesses are installed in the pressurized area of the fuselage.

When quad cables are installed in unpressurized areas like the wings, they are installed in an overbraided shield to prevent electro-magnetic interference during lightning strikes.



APPLICATION

QUAD CABLE AND QUADRAX CONTACT: MATERIALS AND TOOLS

Quad Cable Construction

A quadrax harness for the ethernet data transmission includes 2 contacts that have pins or sockets, and the quad cable. In this topic, we will look at the quad cable in more detail.

The quad cable is specified in the ESPM as:

- Type KB

Or

- Type KD. This last one is lighter and is used where the EMIs are high. KD24 will be used more often than KB24 (independently of the application and location).

Note: On A350, ESPM is a Business category and no more a manual, named STD Practices - Electrical.

These two quad cables have an outer diameter of approximately 5 mm and their internal construction is as follows:

- Four single stranded wires are equally twisted around a center filler,
- The individual wires are of AWG 24 and have a silver plated copper core.

Or

- Type KL: KL24 cables have the same wire properties as KD24 wires, but the isolation material of KL24 is thinner than the isolation of KD24.

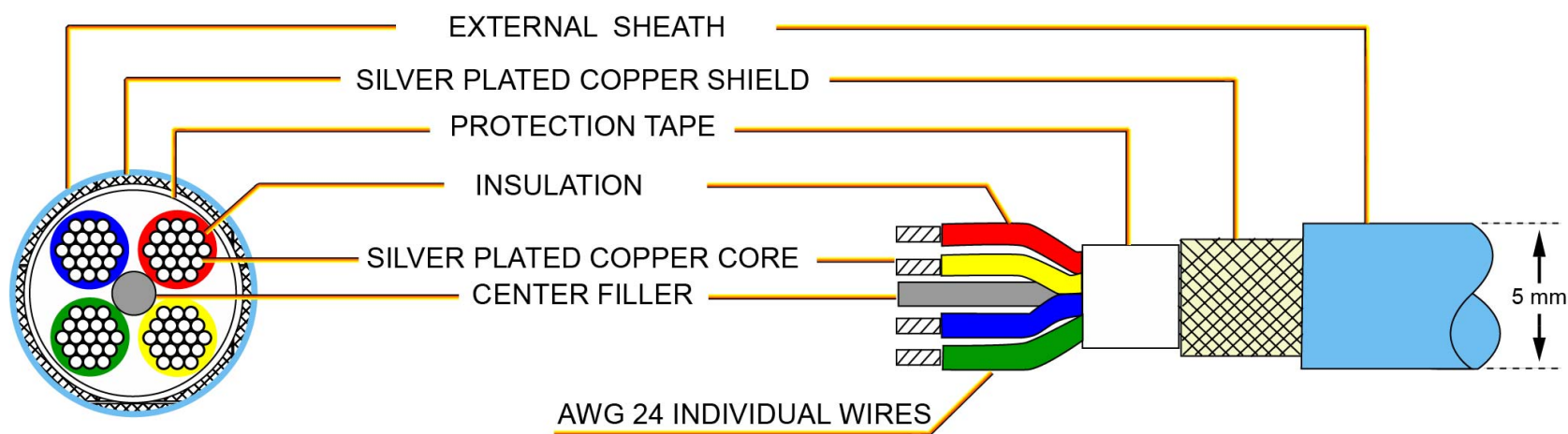
- There is a protection tape around all four wires,

- The shield is made of silver plated copper and the cable is fully insulated by a light blue sheath on which UV Laser marking can be used. The light blue color makes an easy identification in the aircraft.



Quad Cable specification:

- Type: KB
- Type: KD / KL



QUAD CABLE CONSTRUCTION

QUAD CABLE AND QUADRAX CONTACT: MATERIALS AND TOOLS

Quadrax Contact

Quadrax contacts have pins or sockets with the size 24.

All quadrax contacts can be installed in the size-8 cavity of standard connectors.

You can find for example the NAS 1599 as a single round connector, the EN 2997 family (ABS 1340,1343,1426 and 1427) as multiple round connectors (shown on the slide with four quadrax contacts), and the EN 3545 with, in this example, five Quadrax contacts side by side.

The ARINC 600 connectors of avionics components have cavities for quadrax contacts, in this example 22 cavities.

To remove a quadrax contact from the cavity of the main connector, you must use an approved extraction tool.

A quadrax contact with pins has the Airbus standard ABS0973.

It has a contact body made out of copper alloy, and four pin contacts, made out of gold plated copper alloy, which are held in position by an insert and a spacer.

There is also a ferrule which is used to give the electrical contact to the cable shield.

Note: The contact pins of size 24 are fragile.

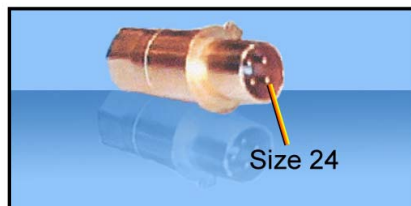
A quadrax contact with sockets has the Airbus standard ABS0974, and has the same basic parts as the plug: a contact body, four socket contacts with an insert and a spacer, and a ferrule.

The quadrax contacts are connected to the cable by crimping.

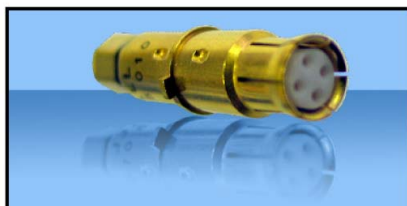
First, you must crimp the individual wires to the contacts with an approved hand tool with the applicable locator.

After installation of the pins, you must fully crimp the contact with a second approved hand tool.

QUADRAX CONTACTS



with Pins



with Sockets

- Connector Cavity size 8

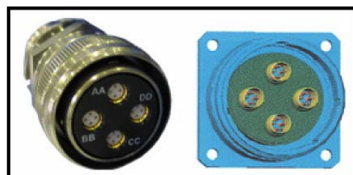
22 Cavities
for
Quadrax
Contacts



NAS 1599



EN 3545



EN 2997 family



Extraction Tool



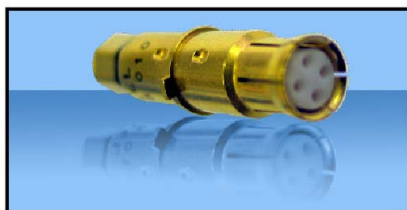
QUADRAX CONTACT

XN113211 - X04NTT0 - XM20P4NEWTECH01

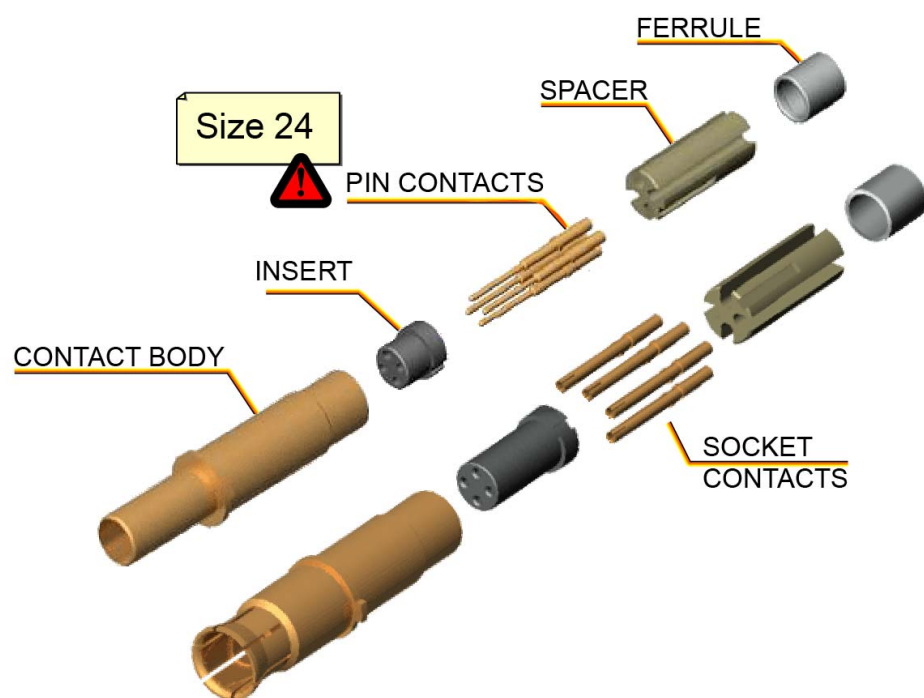
QUADRAX CONTACT



with pins ABS 0973



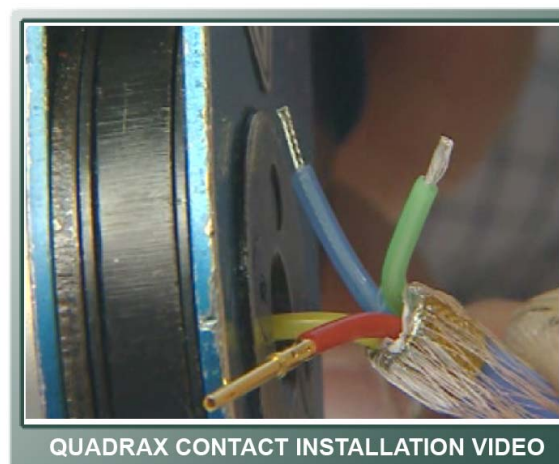
with sockets ABS 0974



CONTACT CRIMPING
TOOL



CONTACT BODY
CRIMPING TOOL



QUADRAX CONTACT INSTALLATION VIDEO

QUADRAX CONTACT

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AVIONICS COMPUTER EVOLUTION PRESENTATION

Avionics Computer Generations 1 to 3

There are different generations of computers for aircraft systems:

- First Generation: processing and storage resources that only use electronic logic cards (e.g. MARKER receiver).
- Second Generation: processing and storage resources that use electronic logic cards hosting software elements. Some of the software elements (A/C system application) included in the On-Board Replaceable Modules (OBRMs) can be replaced in line. Some other parts are resident software and can only be replaced in shop. Note: The A/C system functions are done from the OBRM (e.g.: A330/340 Flight Management and Guidance Envelop Computer (FMGEC)).
- Third Generation: processing and storage resources that use electronic logic cards, resident software and A/C system application. This application does an A/C function and can be uploaded into the computer in line (e.g.: A380/350 Flight Management Computer (FMC)).



1st GENERATION COMPUTERS

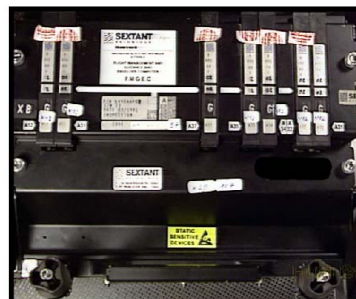
Interface, processing & storage resources based on:

- Electronics logic only.

Note: In case of failure or computer evolution, replace the entire computer.



EX.: Marker receiver

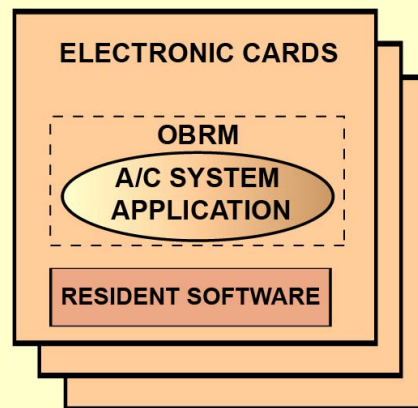


2nd GENERATION COMPUTERS

Interface, processing & storage resources based on:

- Electronics logic,
- Resident software,
- Application.

Note: In case of failure or computer evolution, possibility to replace only the OBRM.



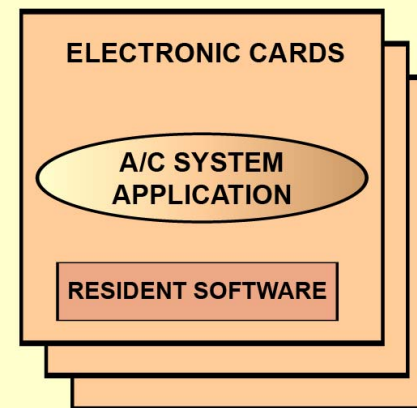
EX.: A330/A340 FMGEC



3rd GENERATION COMPUTERS

Interface, processing & storage resources based on:

- Electronics logic,
- Resident software,
- Application,
- No more OBRM,
- Data loading for software modification.



EX.: A380/A350 FMC

OBRM: On-board Replaceable Module

AVIONICS COMPUTER GENERATIONS 1 TO 3

AVIONICS COMPUTER EVOLUTION PRESENTATION

Avionics Computer Generation 4: IMA

With the new avionics concept Integrated Modular Avionics (IMA), most of the A/C system functions that were done by conventional LRUs are done by avionics applications. These independent applications are hosted in shared IMA modules, called Core Processing Input/Output Modules (CPIOMs).

With the IMA concept, a smaller number of computers is necessary for the A/C systems. The maintenance costs are lower because of the smaller number of spare computers.

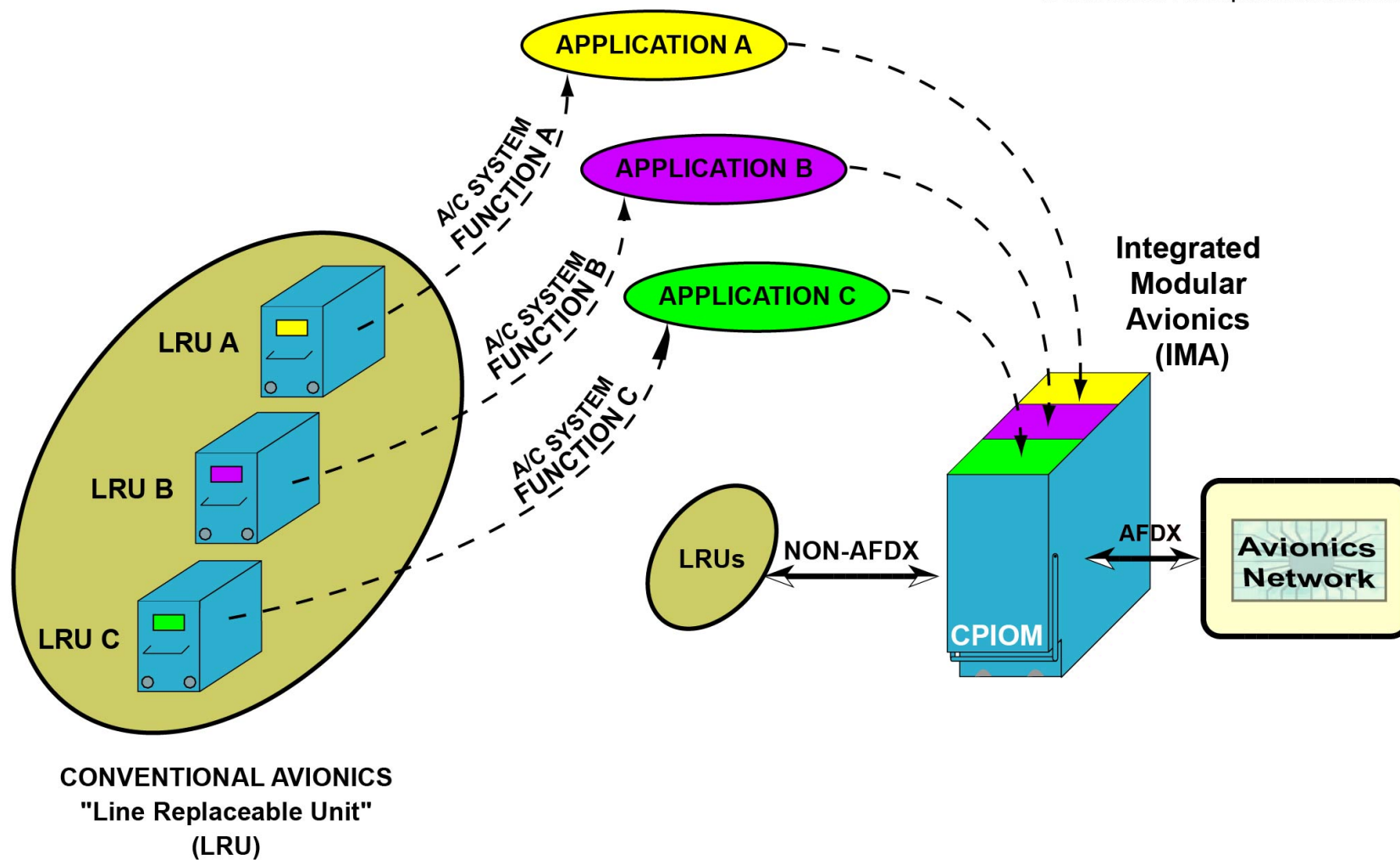
Each CPIOM integrates new hardware and software technologies, hosts these independent applications and gives them the same computing and memory resources. It also supplies an input/output interface to some of the conventional avionics.

A CPIOM is a Line Replaceable Module (LRM).

These LRMs communicate through the avionics network. They use a communication technology developed from a non-aeronautical standard and adapted to aviation requirements.

This technology is called Avionics Full Duplex switched ethernet (AFDX).

CPIOM: Core Processing Input/Output Module
AFDX: Avionics Full Duplex switched ethernet



AVIONICS COMPUTER GENERATION 4: IMA

AVIONICS COMPUTER EVOLUTION PRESENTATION

Computer Versus Application

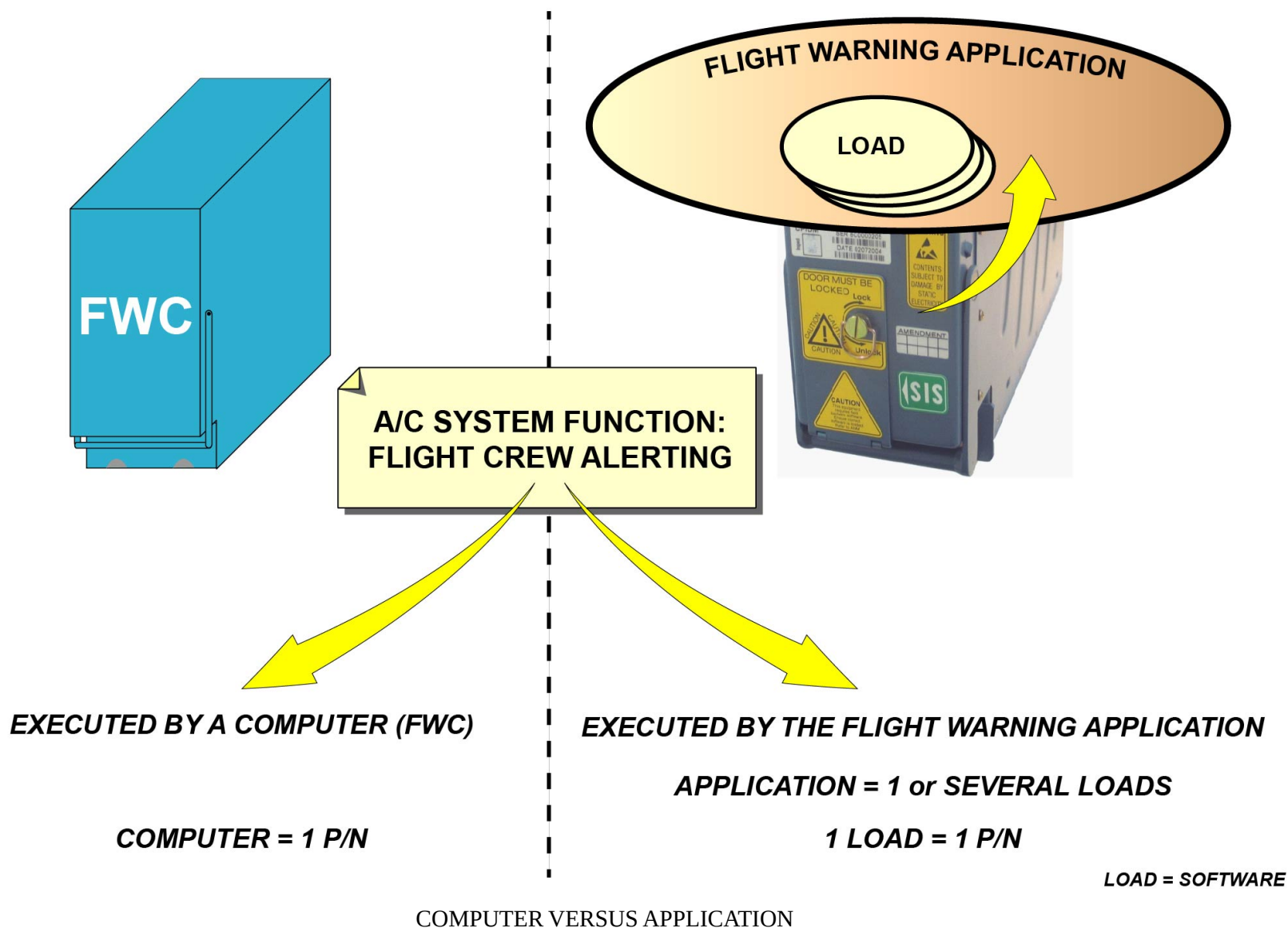
An A/C system function (e.g.: Flight Crew Alerting) can be done by:

- A dedicated hardware computer (e.g.: the Flight Warning Computer (FWC)), or,
- An application made of one or more loads (e.g.: the Flight Warning Application).

Note: A load is a software.

A computer is usually related to a Part Number (P/N) and each load is related to a dedicated P/N.

Note: An A/C system Application is not related to a P/N.

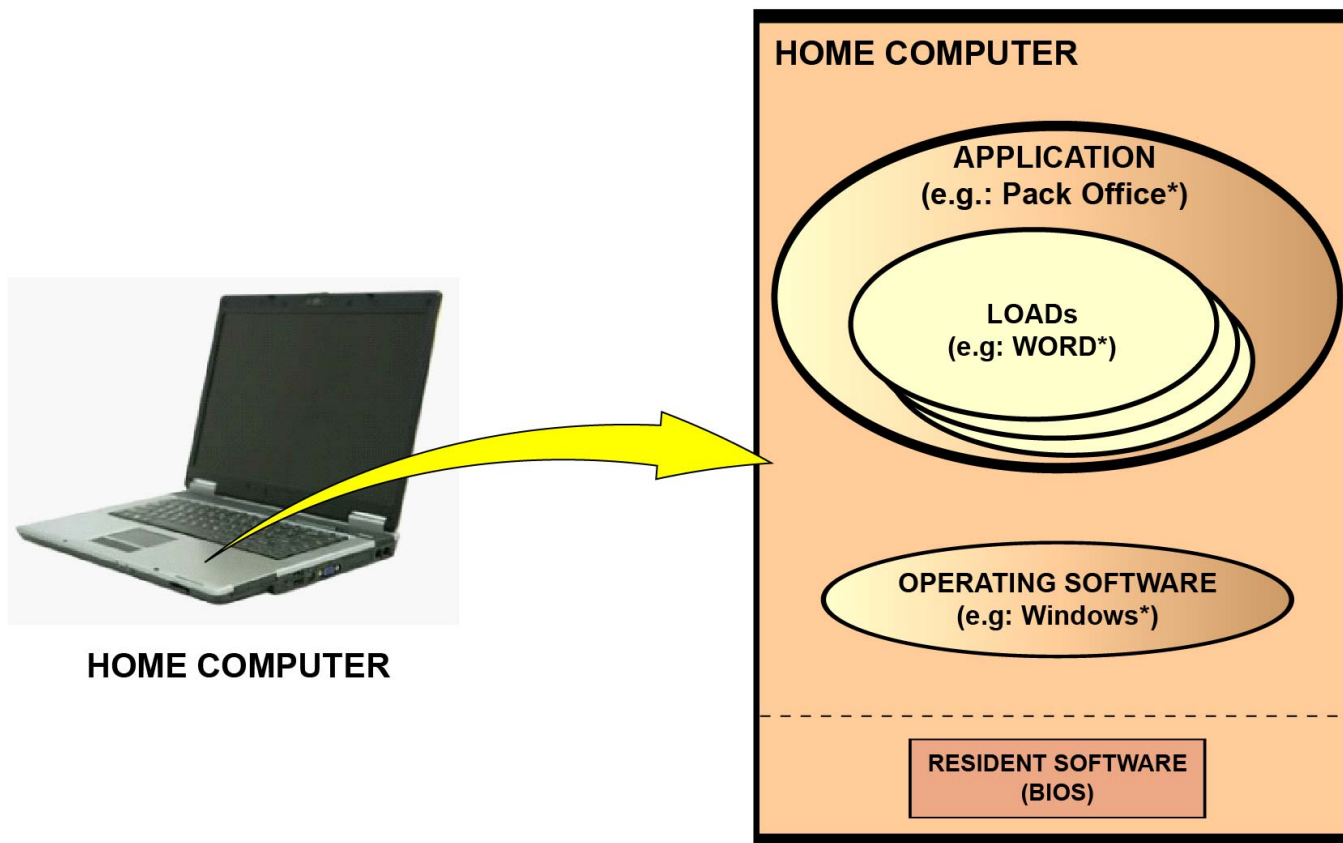


AVIONICS COMPUTER EVOLUTION PRESENTATION

Home Computer Analogy

To make an analogy with a home computer:

- Like an aircraft computer, the home computer has a resident software such as the Basic Input/Output System (BIOS). The BIOS makes sure all the other chips, hard drives, ports and Core Processing Unit operate together.
- Like an aircraft computer, the home computer has an Operating Software (OS) such as WINDOWS. The OS supplies a set of services for the applications that operate on your computer, and it is also the fundamental user interface of your computer.
- The aircraft system application can be illustrated by the "Microsoft Pack Office" application which is a global office automation software solution.
- The "Microsoft Pack Office" application is made of different loads like "Microsoft Word", "Excel", "PowerPoint".



* Microsoft Corporation. All rights reserved

HOME COMPUTER ANALOGY

AVIONICS COMPUTER EVOLUTION PRESENTATION

Aircraft Computer: CPIOM-C1

As an example, we will describe the CPIOM-C1 (A380) to better illustrate the loads and applications.

The CPIOM-C1 includes 5 applications:

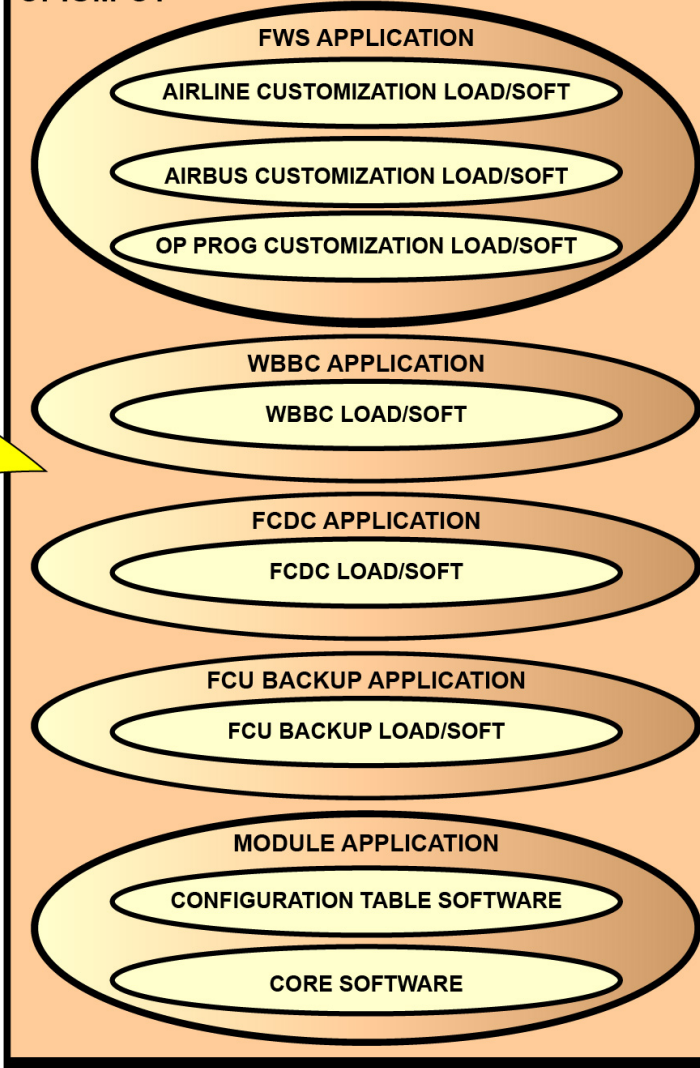
- The Flight Warning System (FWS) Application made of 3 loads:
 - Operational Program customization load
 - Airbus Customization Load
 - Airline Customization Load
- The Weight and Balance Backup Computation (WBBC) Application made of one load:
 - WBBC Load
- The Flight Control Data Concentrator (FCDC) Application made of one load:
 - FCDC Load
- The Flight Control Unit (FCU) Backup Application made of one load:
 - FCU Backup Load
- The Module Application made of 2 loads:
 - Core Software
 - Configuration Table Software

Core Processing Input/Output Module (CPIOM-C1) (A380 Example)



FCDC: FLIGHT CONTROL DATA CONCENTRATOR
FCU: FLIGHT CONTROL UNIT
FWS: FLIGHT WARNING SYSTEM
OP: OPERATIONAL
PROG: PROGRAM
SOFT: SOFTWARE
WBBC: WEIGHT AND BALANCE BACKUP COMPUTATION

CPIOM-C1



AIRCRAFT COMPUTER: CPIOM-C1

AVIONICS COMPUTER EVOLUTION PRESENTATION

Data Concentrator/Converter

The different types of data converters installed in the aircraft can be:

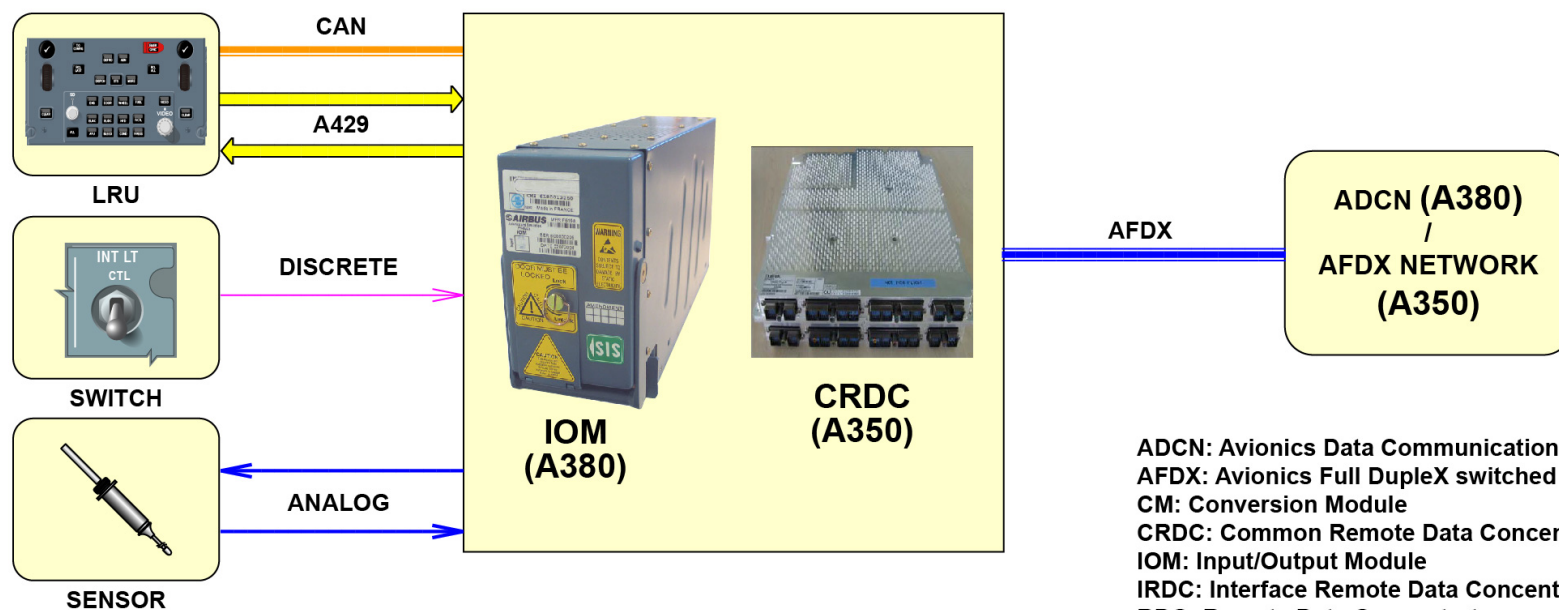
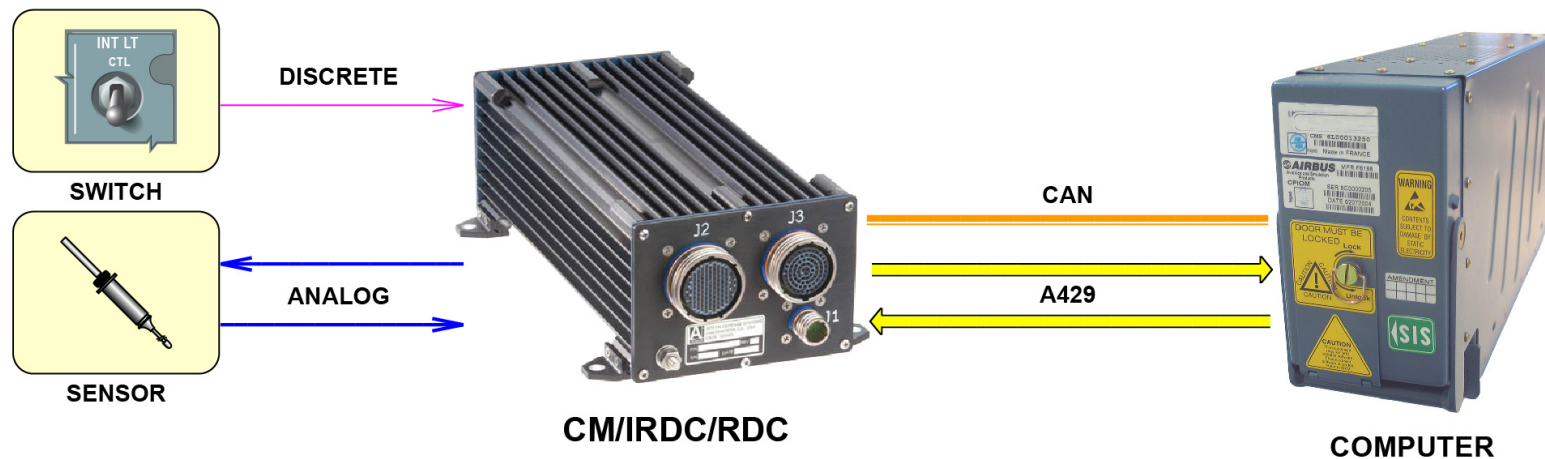
- Conversion Modules (CMs),
- Interface Remote Data Concentrators (IRDCs),
- Remote Data Concentrators (RDCs).

Their function is to convert an analog or discrete input data into a digital ARINC 429 (A429) or Controller Area Network (CAN) output and vice versa.

Other types of data converters can be:

- Common Remote Data Concentrators (CRDCs),
- Input-Output Modules (IOMs).

Their function is to convert an analog/discrete/A429/CAN input data into an Avionics Full Duplex switched ethernet (AFDX) output data and vice versa.



DATA CONCENTRATOR/CONVERTER

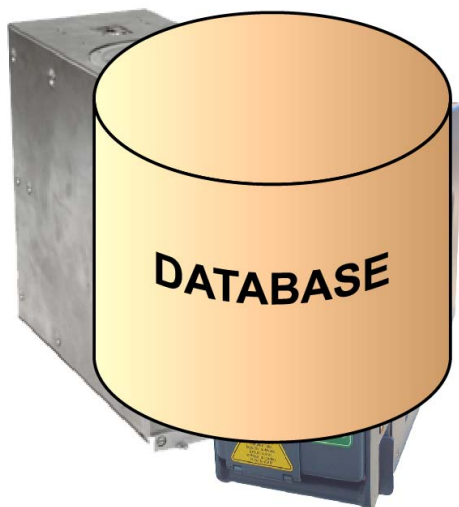
ADCN: Avionics Data Communication Network
AFDX: Avionics Full Duplex switched ethernet
CM: Conversion Module
CRDC: Common Remote Data Concentrator
IOM: Input/Output Module
IRDC: Interface Remote Data Concentrator
RDC: Remote Data Concentrator

AVIONICS COMPUTER EVOLUTION PRESENTATION

Database & Repository

A database is a space of storage device allocated to keep data available (e.g. Data Memory Module of APU, or the navigation database, in the flight management computer which stores the data related to airports, VOR stations, DME stations...).

A repository is a space of storage device (e.g.: hard disk) allocated to store a copy of A/C system computer software. This copy can be uploaded into an A/C computer, for example, after an installation procedure.



DATABASE: storage space device allocated to **KEEP DATA** available

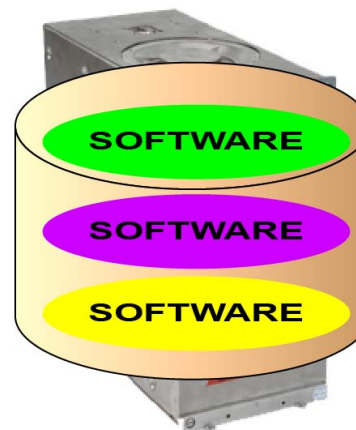
(e.g.: - Navigation Database of the Flight Management Computer
or APU Data Memory Module)

REPOSITORY: storage space device allocated to **STORE** a **COPY** of A/C system computer software



A/C COMPUTER

=



ONBOARD REPOSITORY

DATABASE & REPOSITORY

AVIONICS COMPUTER EVOLUTION PRESENTATION

Server

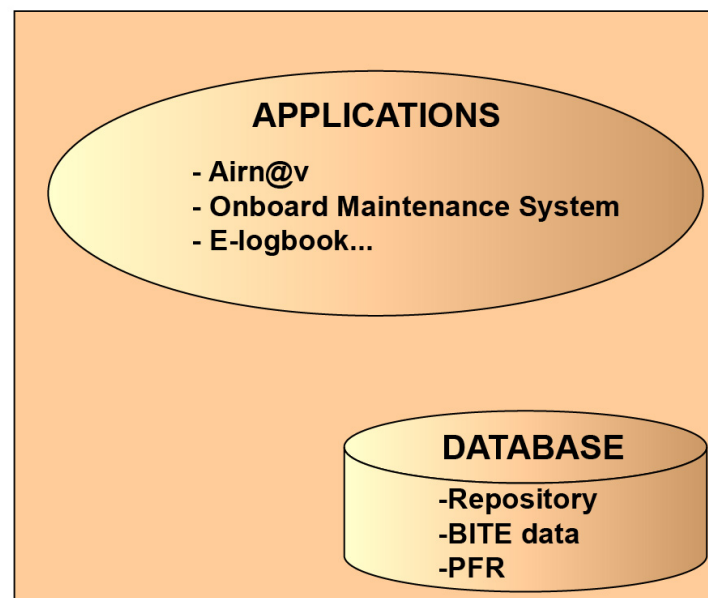
A server has two functions:

- To store applications (Airm@v, OMS, E-logbook, etc.) and data (repository, BITE data, PFR, etc.) into a database,
- To supply these applications and data to the connected components (A/C computers, printer, Display Units, etc.).



Ex: A380 Server

=



SERVER FUNCTION:

**Stores Applications & Data,
Supplies Applications & Data to connected components (A/C computers, Printers, Display Units...)**

SERVER

AVIONICS COMPUTER EVOLUTION PRESENTATION

Cabinet Concept

A cabinet is an aircraft computer assembly that hosts applications and data that will be used by other computers. A cabinet has the same high-level function as a server.

But there is a basic difference between a server and a cabinet:

- A server is a unique LRU made of several electronic cards that can only be removed in shop or manufacturer facilities,
- A cabinet is a Line Replaceable Unit (LRU) that is made of several blades which are Line Replaceable Items (LRIs).

A blade is an electronic card that can be independently removed from the cabinet.

A cabinet can host several types of blades:

- Power supply blades, which supply power to other LRIs,
- Storage blades, which supply storage capacity to host applications,
- Processing blades, which supply processing capabilities to applications hosted by the storage blades,
- Cabinet management blade, which manages the allocation of cabinet resources in the most efficient way,
- Video management blade, which implements and manages graphical generation functions.

On A380 the Head End Server Unit (HESU), and on A350 the Aircraft / Open-world Network Server Unit (ASFC and OSFC), are examples of cabinets installed on Airbus aircraft.

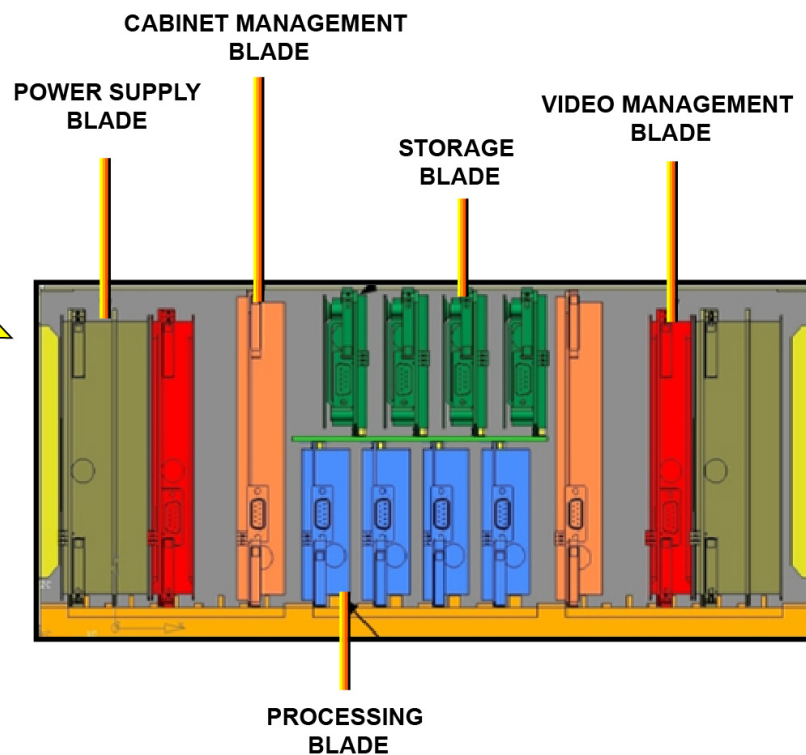


**Ex of A350 CABINET
(ASFC or OSFC)**



**Ex of A380 CABINET
(HESU)**

CABINET = 1 Line Replaceable Unit (LRU)
BLADE = 1 Line Replaceable Item (LRI)
ASFC = Avionics Server Function Cabinet
OSFC = Open world Server Function Cabinet
HESU = Head-End Server Unit



CABINET CONCEPT

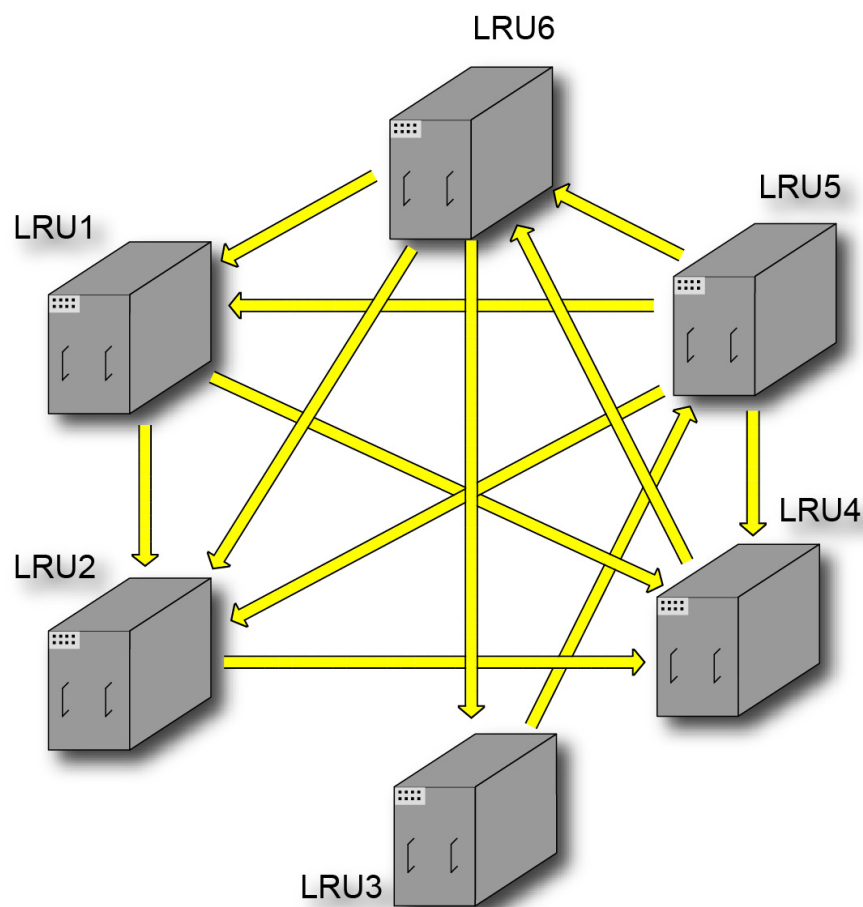
DIGITAL BUS PRESENTATION

A429BUS

In the past, the aircraft avionics systems used primarily the ARINC 429 data buses to transmit data. An ARINC 429 data bus has a maximum data transport rate of 100 thousand bit per second (100 kilo bps) and the data transmission goes only in one direction. Each individual avionics component must have a wired connection to all other computers that will use the data. This is called a point-to-point interconnection.

With A429 standard, each emitter can transmit data up to 20 receptors. If, for example, a new LRU is added because of a modification, you must install new wires to all other related computers.

ARINC 429 WORLD



- Point-to-Point Interconnection
- Bit Rate up to 100 Kbps
- Unidirectional bus
- 1 emitter up to 20 receptors

A429BUS

DIGITAL BUS PRESENTATION

CAN BUS & Classic Ethernet

The CAN (Control Area Network) Bus is a bidirectional bus used for the transmission and the reception, with a data speed of 1Mbit per second. Because of the bidirectional bus capability, the primary advantage, compared to the ARINC 429 standard, is that less wiring is necessary. In terms of general bus communication philosophy, the CAN buses broadcast the data to all receiver LRUs.

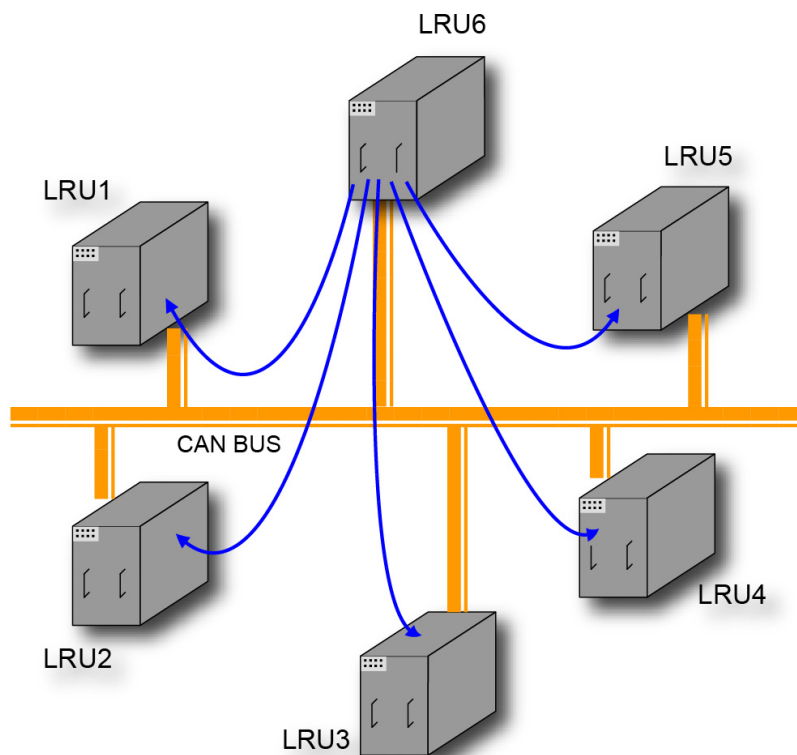
The classic Ethernet-based data communication needs just a connection of each unit to the common Ethernet bus, used for both transmission and reception, and the data speed is increased up to 10 million bits per second or mega bps in short.

If a new LRU has to be added, the hardware modification just needs a new connection to the Ethernet bus. The ARINC 629 is an example of a common Ethernet bus interconnection for aircraft data networks.

In terms of general bus communication philosophy, the Ethernet buses multicast the data to dedicated receiver LRUs only.

Main limitation of the Ethernet bus is that data from different LRUs can enter into collision; in this case each emitted signal is lost.

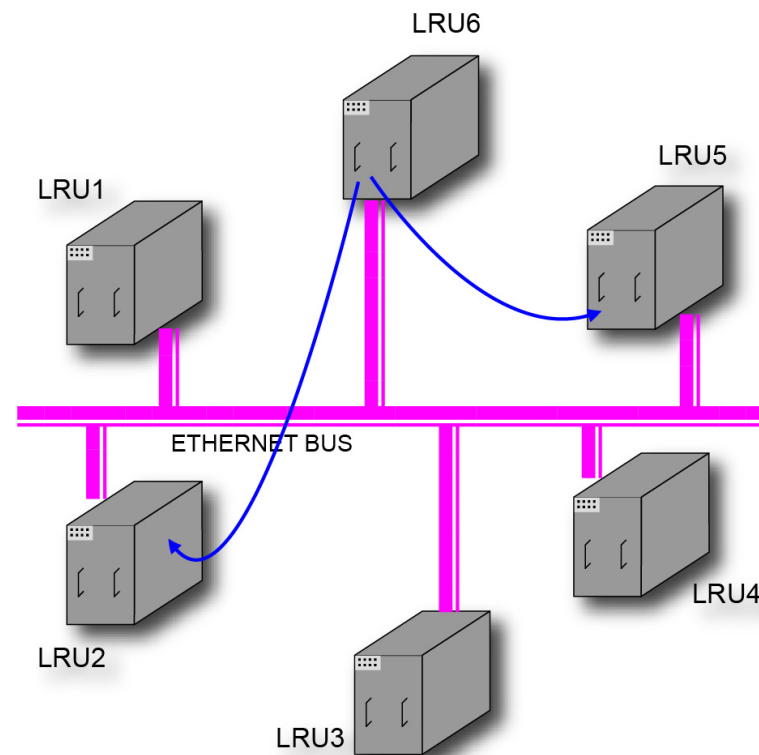
CAN BUS (Data broadcast)



Common Bus Interconnection

- Bi-directional bus
- Bit Rate up to **1 Mbps**
- Data are broadcasted on the bus

CLASSIC ETHERNET (Data Multicast)



Common Bus Interconnection

- Bi-directional bus
- Bit Rate up to **10 Mbps**
- Data are multicasted on the bus

CAN BUS & CLASSIC ETHERNET

DIGITAL BUS PRESENTATION

CAN BUS & Classic Ethernet (continued)

ETHERNET COMMUNICATION PRINCIPLE

Classic Ethernet-based communication rules are comparable to those which polite people use during a meeting.

Multiple access means that anybody can talk to all people at the table and all can listen to the speaker at the same time.

For the computer this also means that all have access to the Ethernet bus at the same time.

All people have to listen first and only start to speak if the medium is silent.

Also the computer have to listen first and are only allowed to transmit data if the bus is empty.

In a few cases it may happen that two transmitters, or people, start talking at the same time.

In this case both detect this collision and stop the conversation immediately, this is called collision detection.

After a few micro-seconds of listening the first computer starts to transmit again and the normal conversation continues.

The waiting time is random so that never the same computers start the conversation again at the same time.

ETHERNET COMMUNICATION PRINCIPLE

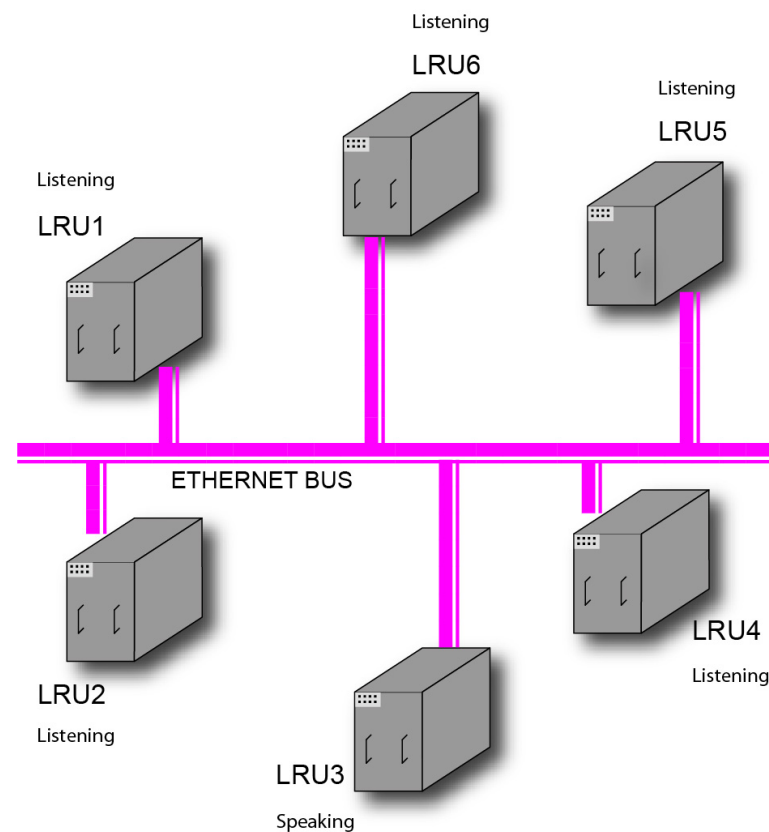
-> COLLISIONS HAPPEN WHEN SEVERAL
USERS EMIT AT THE SAME TIME



Collision detected:

- all stop transmission
- after few micro-seconds one computer starts again
- random waiting time prevents that same computers start again at same time

CLASSIC ETHERNET



CAN BUS & CLASSIC ETHERNET - ETHERNET COMMUNICATION PRINCIPLE

DIGITAL BUS PRESENTATION

AFDX Switch

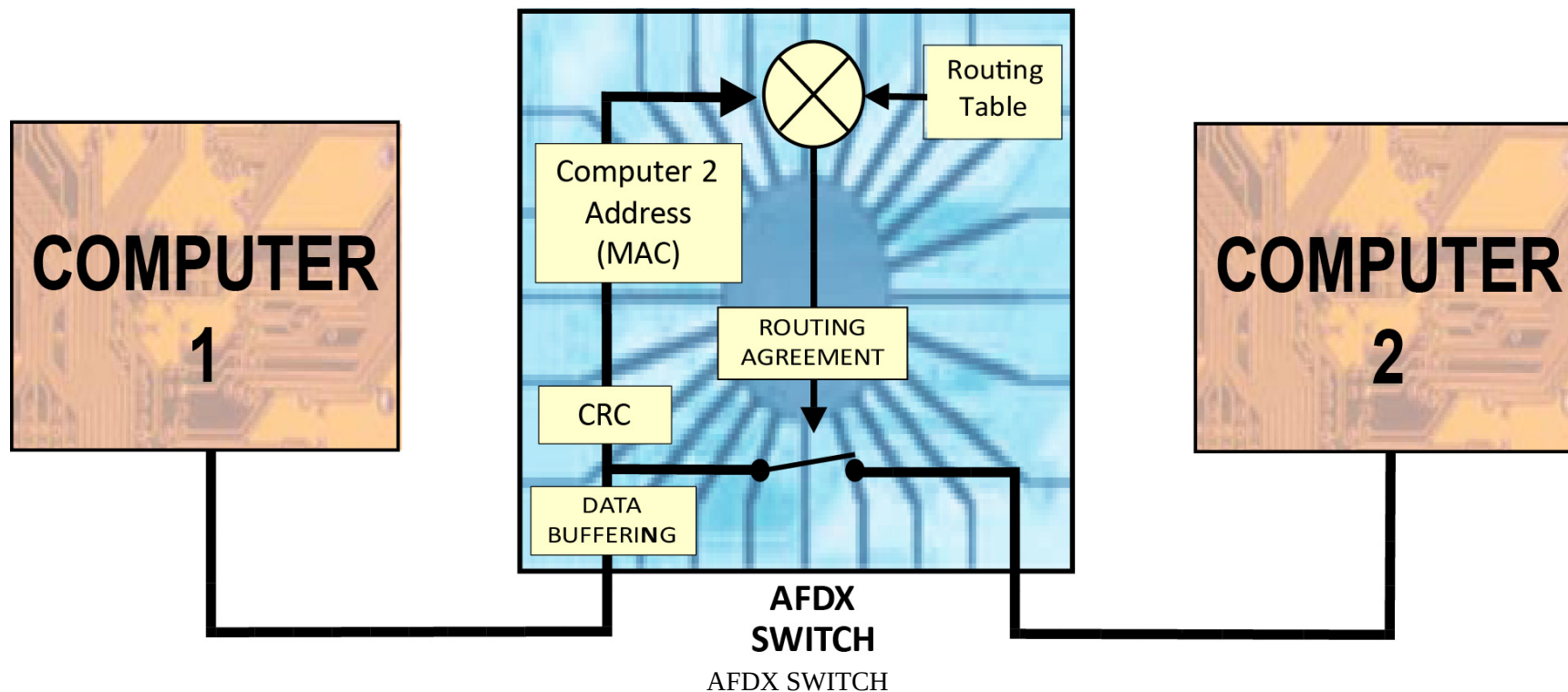
Classical switches first check the MAC address of the destination. This address is compared to a routing table and if the address is available the corresponding switch is closed and sends the complete frame to the destination computer and only to this one. The AFDX switches also check the CRC and therefore need first to store the complete frame.

Note that the "switched" data are always sent in one shot (never split).

AFDX SWITCH

SWITCH Functions:

- data buffering
- data integrity check (CRC)
- data routing from one LRU to another one (Use of MAC Address)



XN113211 - X04NTT0 - XM46P1NEWTECH01

DIGITAL BUS PRESENTATION

Router

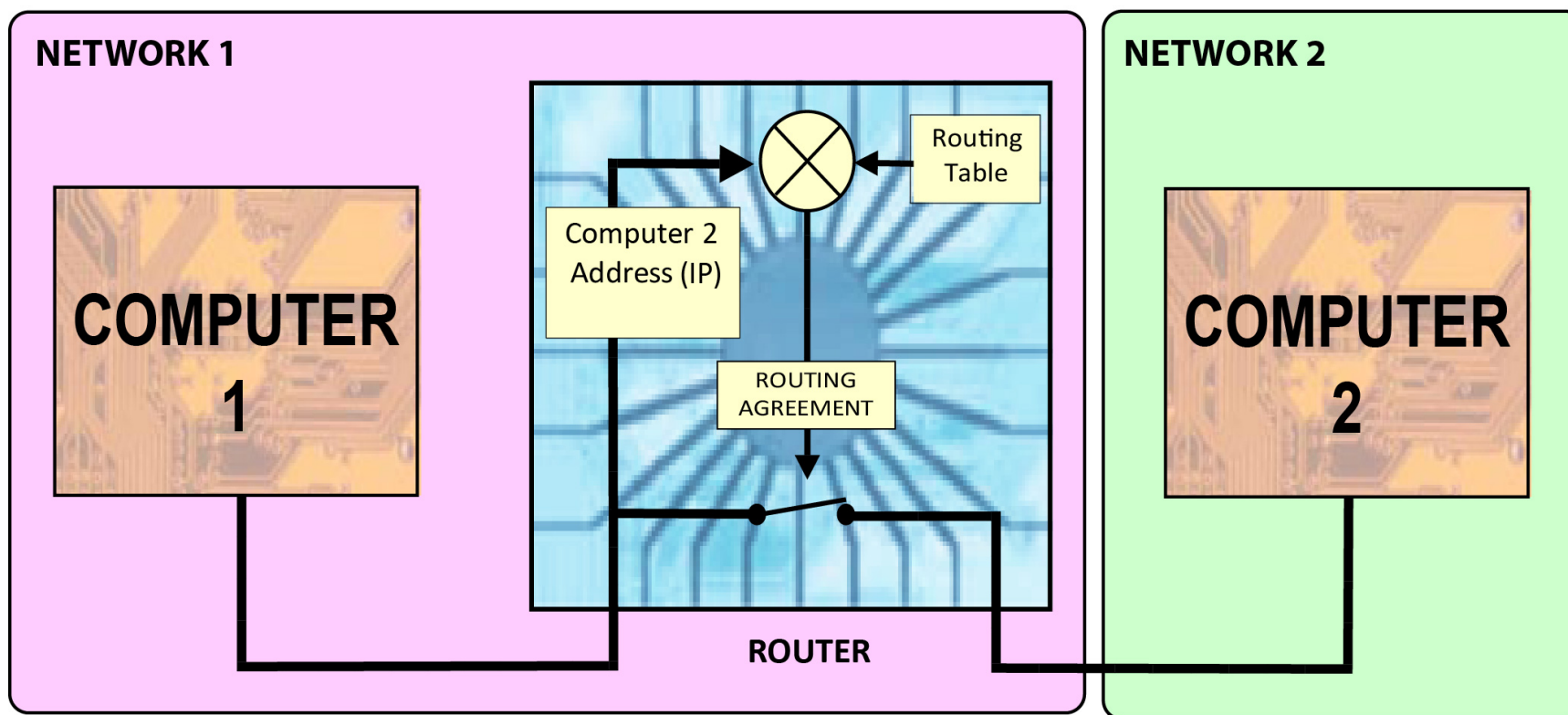
The router is also called IP-switch because it uses the IP address to decide whether to forward each received packet, and which network interface to use to send the packet. The decision is based on the packet IP destination address, and routing information is held within the router in a routing table. When communication between different networks or sub-networks is required a router is used. A router can divide a network into sub-networks, filtering the IP addresses that can pass.

Note that the "routed" data can be split if there are multiple transmissions at the same time.

ROUTER

ROUTER Functions - data routing from one LRU to another one (Use of IP Address)

-> since computer hard identification (MAC) is not necessary, capability to route data on extended networks (ex: internet)



ROUTER

DIGITAL BUS PRESENTATION

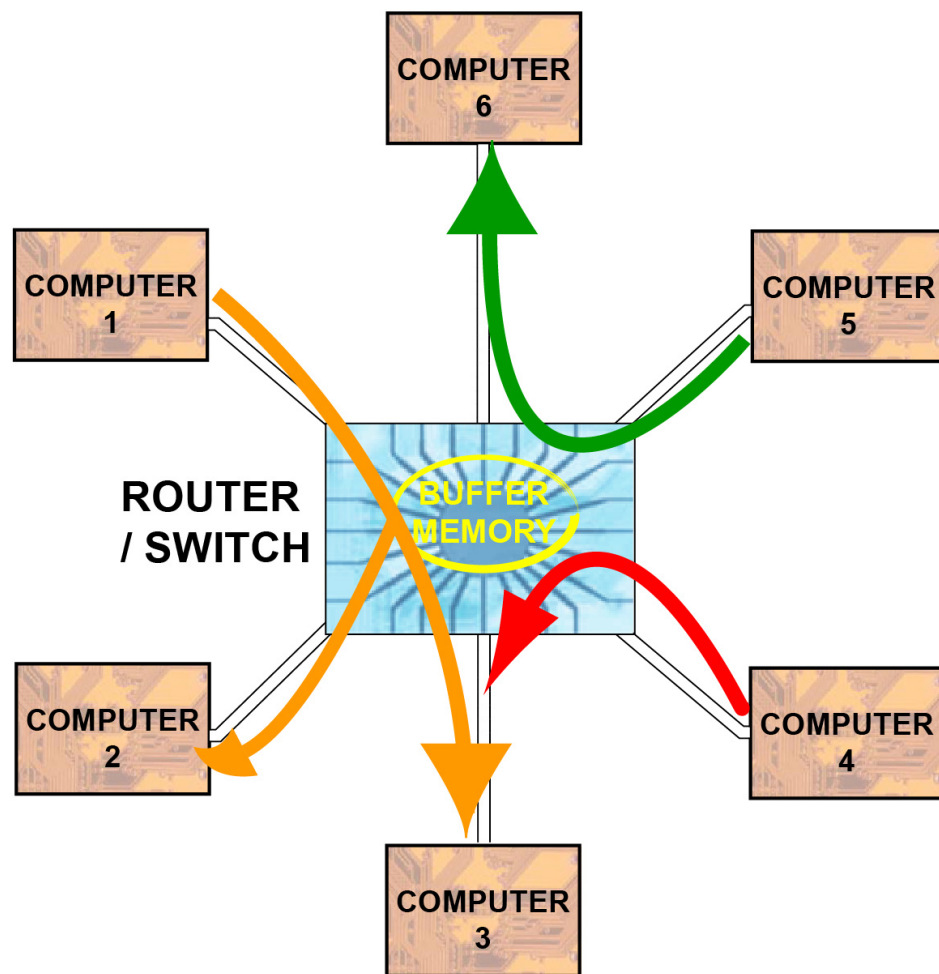
AFDX Network / ADCN

A problem with the classic Ethernet is that if you have many computers you may get long waiting times to detect a silent medium that allows you to transmit the information. Therefore if you have time critical data transmissions like in the avionics system, you need to divide the network with intermediate devices to regulate the traffic.

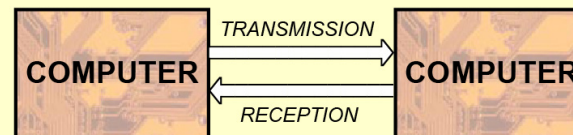
A switched network that operates in full duplex operation mode (transmission and reception of data at the same time) network is an Avionics Full DupleX switched Ethernet (AFDX) network. The LRUs connected to this network can manage full duplex operations.

The AFDX technology uses the Virtual Link (VL) communication concept.

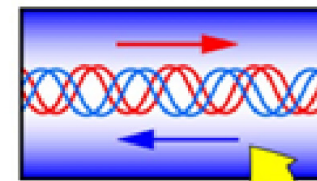
AFDX Network / ADCN



FULL DUPLEX OPERATION



BOTH COMPUTERS ARE ABLE TO TRANSMIT & RECEIVE DATA AT THE SAME TIME



- Bi-directional Full Duplex bus
- Bit Rate up to 100 Mbps
- Use of Switches -> no collision
- No waiting time
- Based on Virtual Links

AFDX NETWORK / ADCN

DIGITAL BUS PRESENTATION

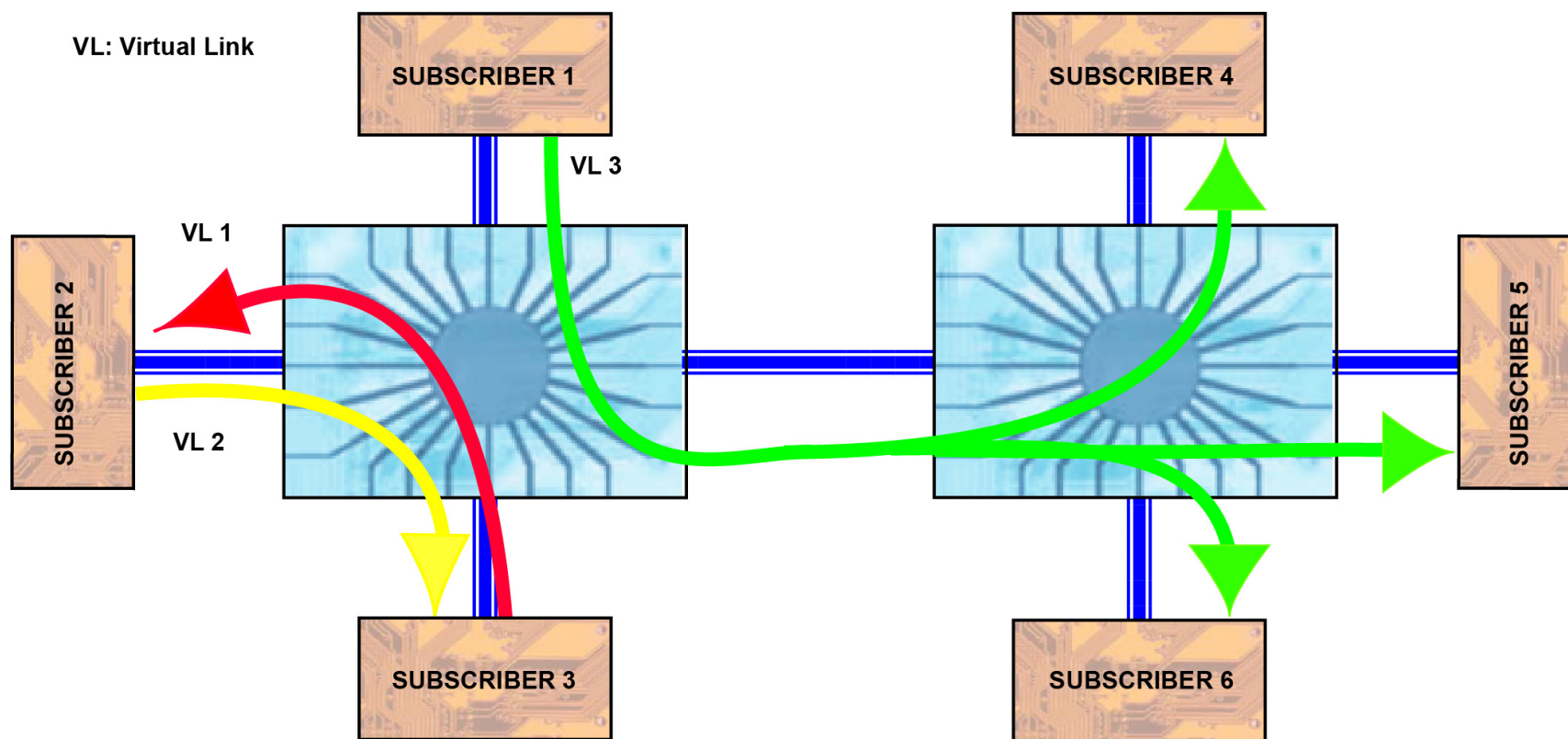
Virtual Link

The Virtual Link could be described as a pipe on the network.
Every Virtual Link is defined in advance and controlled through configuration files at both subscribers and switches level.
AFDX switches are interchangeable but may require software reconfiguration.

In the ADCN, the communication is based on the AFDX Virtual Link.

Concept whose main characteristics are:

- a Virtual Link is mono-directional,
- a Virtual Link has a unique emitter and one or several receivers,
- a Virtual Link always follows a frozen route on the network.



AFDX Virtual Link Concept

- a Virtual Link is mono-directional
- a Virtual Link has a unique emitter and or several receivers
- a Virtual Link always follows a frozen route on the network

VIRTUAL LINK

DIGITAL BUS PRESENTATION

Firewall

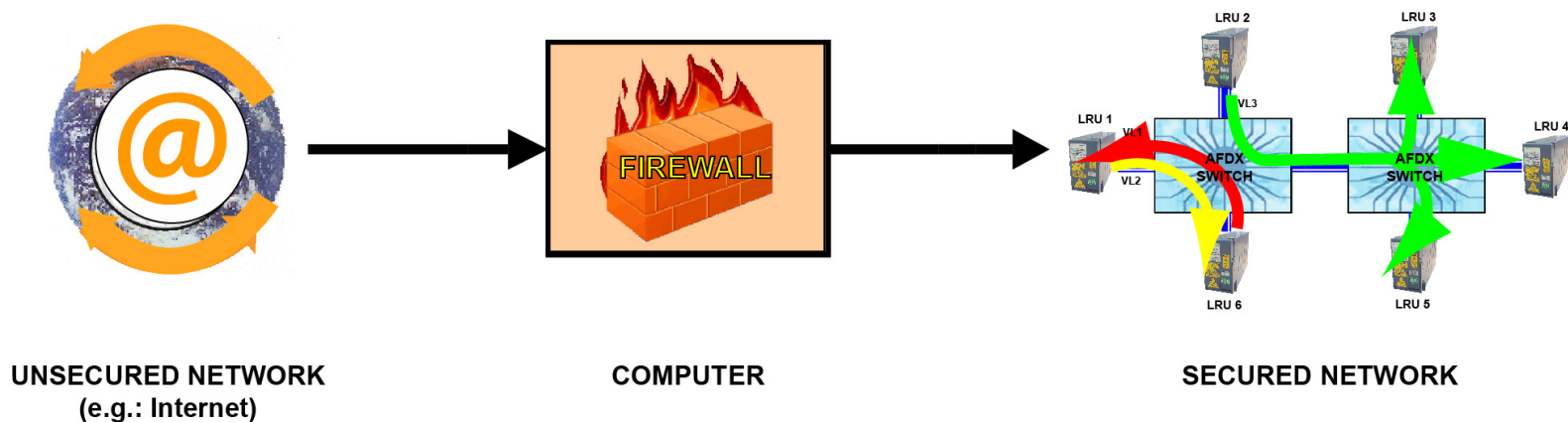
A firewall is a software that filters all data sent from an unsecured network to a secured network.

The software hosted in a computer uses two different rules related to the security level to be implemented:

What is not forbidden is permitted (e.g: philosophy implemented on internet network),

What is not permitted is forbidden (implemented on A380 & A350).

A firewall with the principle of "What is not permitted is forbidden" has a maximum security level.



FIREWALL

Software hosted in a computer which obeys 2 different rules to filter data:

->what is not forbidden in the table is permitted (Internet)

->what is not permitted in the table is forbidden (A380 & A350)

FIREWALL

A/C SOFTWARE MAINTENANCE OPERATIONS

Software Uploading

The Software uploading is done during ground operations to transfer software from media (USB key/CD/DVD/Repository) called sources to a target computer. Software can also be sent by the airline software administration (ground repository) A350 only.

Software uploading is done by the mechanics from an Onboard Maintenance Terminal.

Note: When the software that you want to upload is a new version of the one currently loaded in the computer, it is a software UPGRADING operation (e.g.: application of a Service Bulletin).

A Field Loadable Software (FLS) is a software that can be loaded in line with no necessary shop equipment or infrastructure.

All software given in the maintenance manual for software upload operations are FLSs.

An FLS is uploaded into a computer from a CD/DVD/USB key (A380) or an USB Key/wireless datalink (A350).

**FROM EXTERNAL
DEVICE
(New SW Upload)**

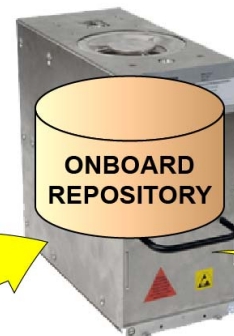


**CD/DVD
(A380 only)**



**USB Key
(A350)**

**FROM ONBOARD
REPOSITORY
(SW Re-load)**



**ONBOARD
REPOSITORY**

OR



SOFTWARE

TARGET COMPUTER

**ONBOARD MAINTENANCE
TERMINAL**



WIRELESS

**Airline
software repository
(A350)**

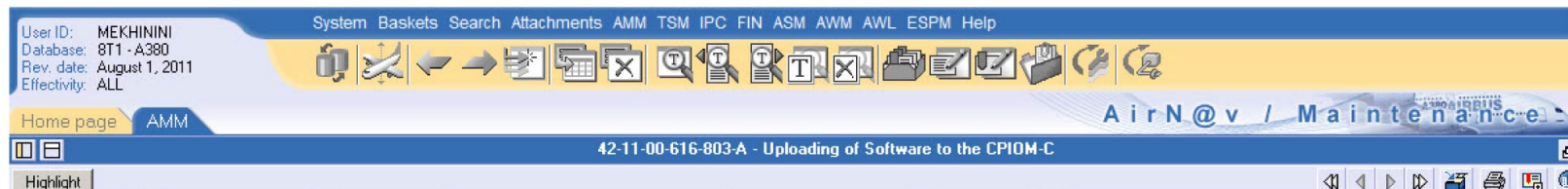
SOFTWARE UPLOADING

XN113211 - X04NTT0 - XM45P1NEWTECH01

A/C SOFTWARE MAINTENANCE OPERATIONS

Uploading AMM Procedure

In Airbus maintenance documentation, only the concept of "software" is used. For software uploading, the maintenance manual gives the list of software to be uploaded. These software can be "Operational Software", "Customization software", Databases, etc.



(5) After the uploading is completed, wait approximately one minute then get access to the Time Limited Item Timer status ([Ref. AMM TASK 31-50-00-860-802](#)) to see the status of the synchronization.

(6) When the message "TIME LIMITED ITEM timers synchronized" comes into view, go to the next step (Ref Para. C)

Subtask 42-11-00-616-004-A

B. Uploading of Software to the CPIOM-C ([Ref. AMM TASK 45-20-00-616-801](#))

NOTE: This procedure tells you how to upload all the equipment software components to get the correct configuration. If it is necessary to upload only part of the equipment software, you can do the steps related to the applicable software component(s) only.

NOTE: You can upload all the software components related to a CPIOM at the same time. To do that, select all the applicable software P/Ns related to the CPIOM to which you want to do the uploading. Then, start the uploading.

NOTE: During this procedure, if an error message is shown, record the related fault code. Then do the related trouble shooting procedure.

- (1) For **LOAD** CPIOM-C1([3TF1](#))

 - (a) Upload these software components in this sequence:
 - SOFTWARE-CPIOM C1 CORE ([3TF1SW1](#))
 - SOFTWARE-CPIOM C1 CONFIGURATION TABLE ([3TF1SW2](#)).
 - (b) When the uploading is completed, upload these software components:
 - SOFTWARE-FCU BACKUP,1 ([4CB1SW1](#))
 - SOFTWARE-FCDC 1 ([1CD1SW1](#))
 - SOFTWARE-WBBC,1 ([2CD1SW1](#))
 - SOFTWARE-FLT WARN 1 OPERATIONAL PROGRAM ([1WW1SW1](#)).
 - (c) When the uploading is completed, upload these software components:
 - SOFTWARE-FLT WARN 1 AIRBUS CUSTOMIZATION ([1WW1SW3](#))
 - SOFTWARE-FLT WARN 1 AIRLINE CUSTOMIZATION ([1WW1SW4](#)).

(2) For **LOAD** CPIOM-C2([3TF2](#))

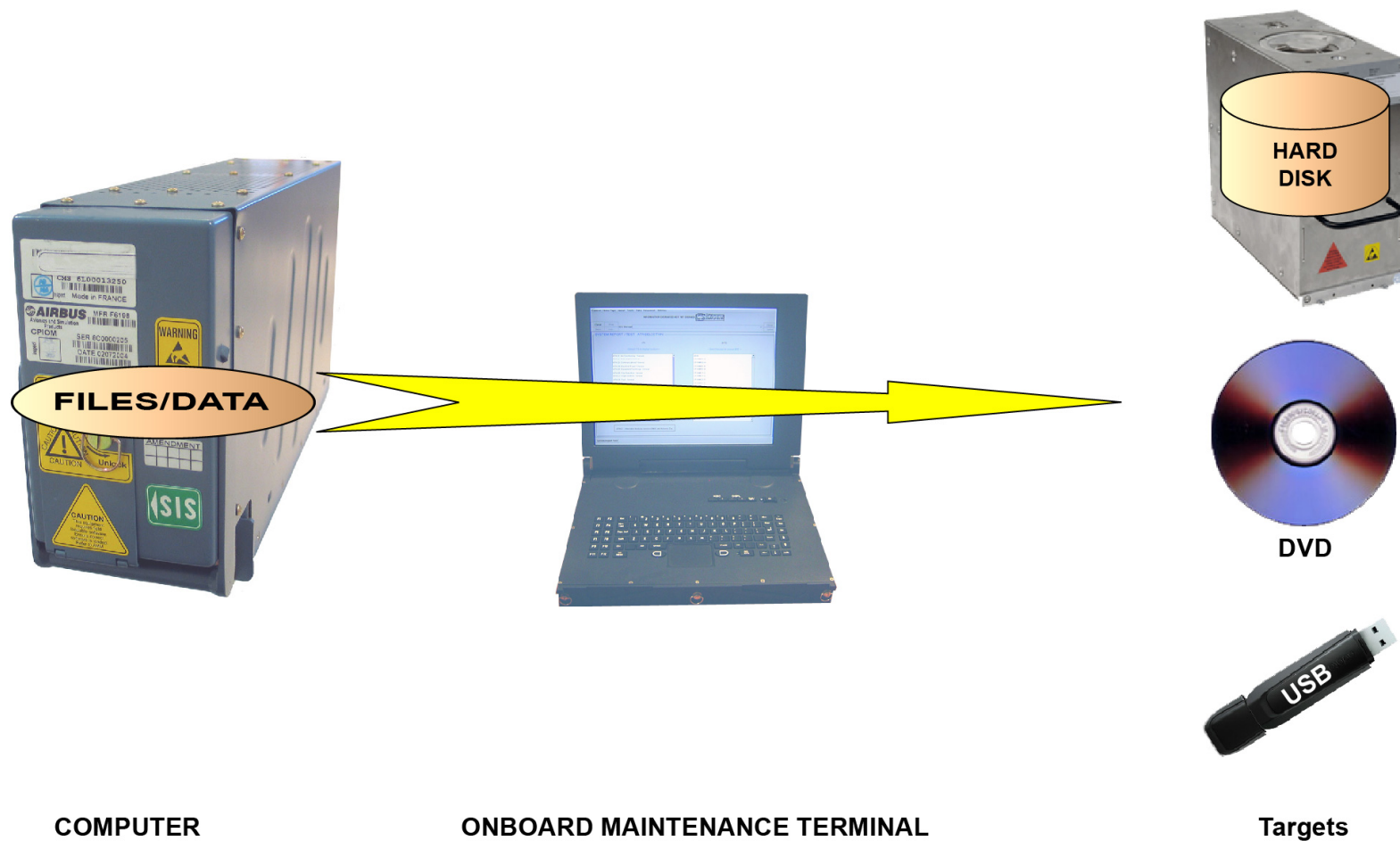
 - (a) Upload these software components in this sequence:
 - SOFTWARE-CPIOM C2 CORE ([3TF2SW1](#))
 - SOFTWARE-CPIOM C2 CONFIGURATION TABLE ([3TF2SW2](#)).
 - (b) When the uploading is completed, upload these software components:
 - SOFTWARE-FCU BACKUP,2 ([4CB2SW1](#))
 - SOFTWARE-FCDC 2 ([1CD2SW1](#))
 - SOFTWARE-WBBC,2 ([2CD2SW1](#))
 - SOFTWARE-FLT WARN 2 OPERATIONAL PROGRAM ([1WW2SW1](#)).
 - (c) When the uploading is completed, upload these software components:
 - SOFTWARE-FLT WARN 2 AIRBUS CUSTOMIZATION ([1WW2SW3](#))
 - SOFTWARE-FLT WARN 2 AIRLINE CUSTOMIZATION ([1WW2SW4](#)).

UPLOADING AMM PROCEDURE

A/C SOFTWARE MAINTENANCE OPERATIONS

File/Data Downloading

The downloading operation is the transfer of files/data from a computer to a media (USB Key/DVD/hard disk).


FILE/DATA DOWNLOADING

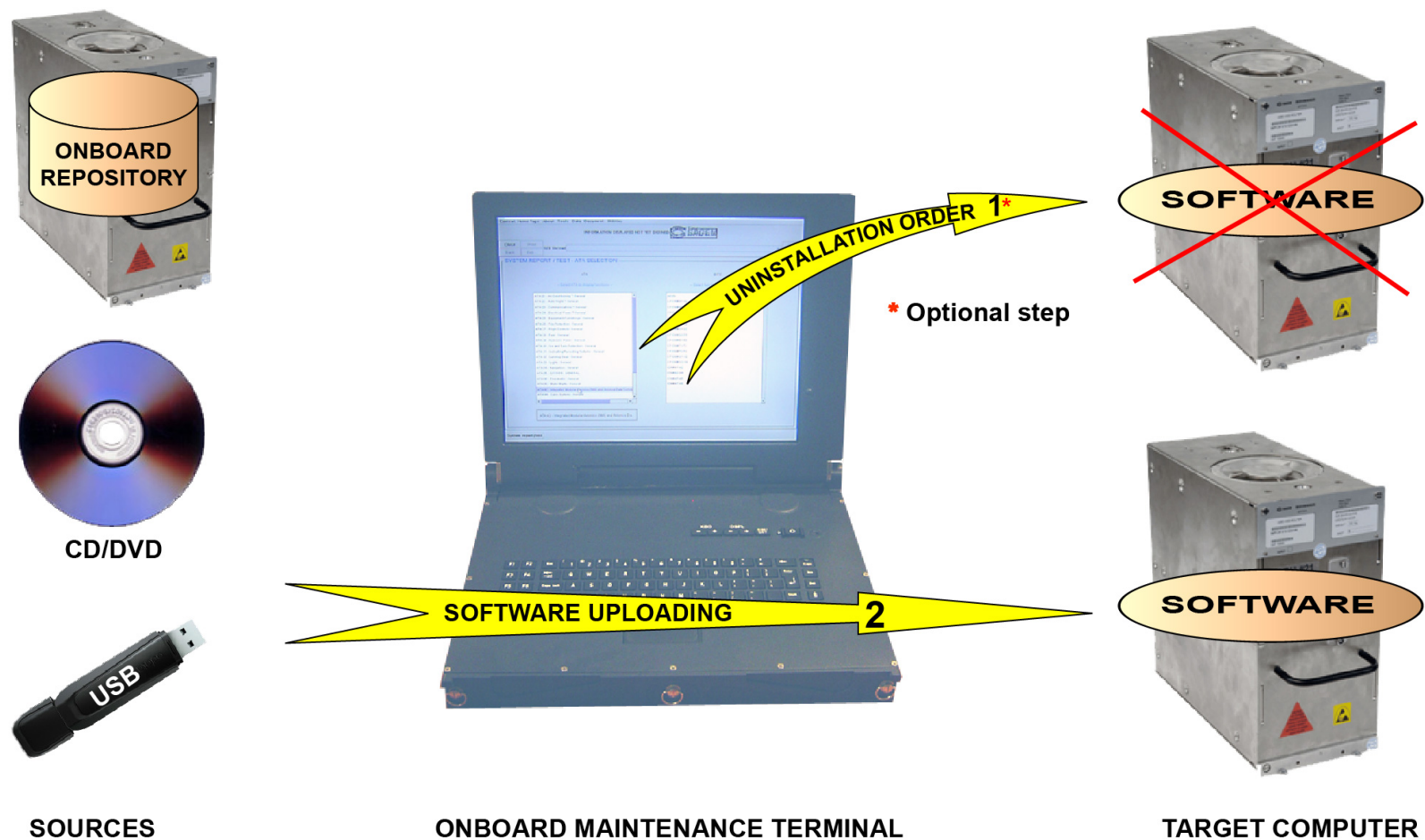
A/C SOFTWARE MAINTENANCE OPERATIONS

Software Repair

The Software repair operations are done when the operation of the software or the function done by the software is not satisfactory.

A software repair can be done through two different procedures:

- software uninstallation followed by new software uploading (initial database are kept),
- or direct new software upload (faulty software and associated database are automatically overwritten).



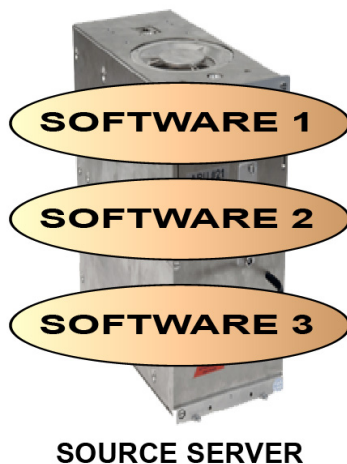
SOFTWARE REPAIR

A/C SOFTWARE MAINTENANCE OPERATIONS

"Restore" of a Server

The restoration of a server is the copying of all software from one source server and their uploading into a different server to make it operational again.

INITIAL CONFIGURATION



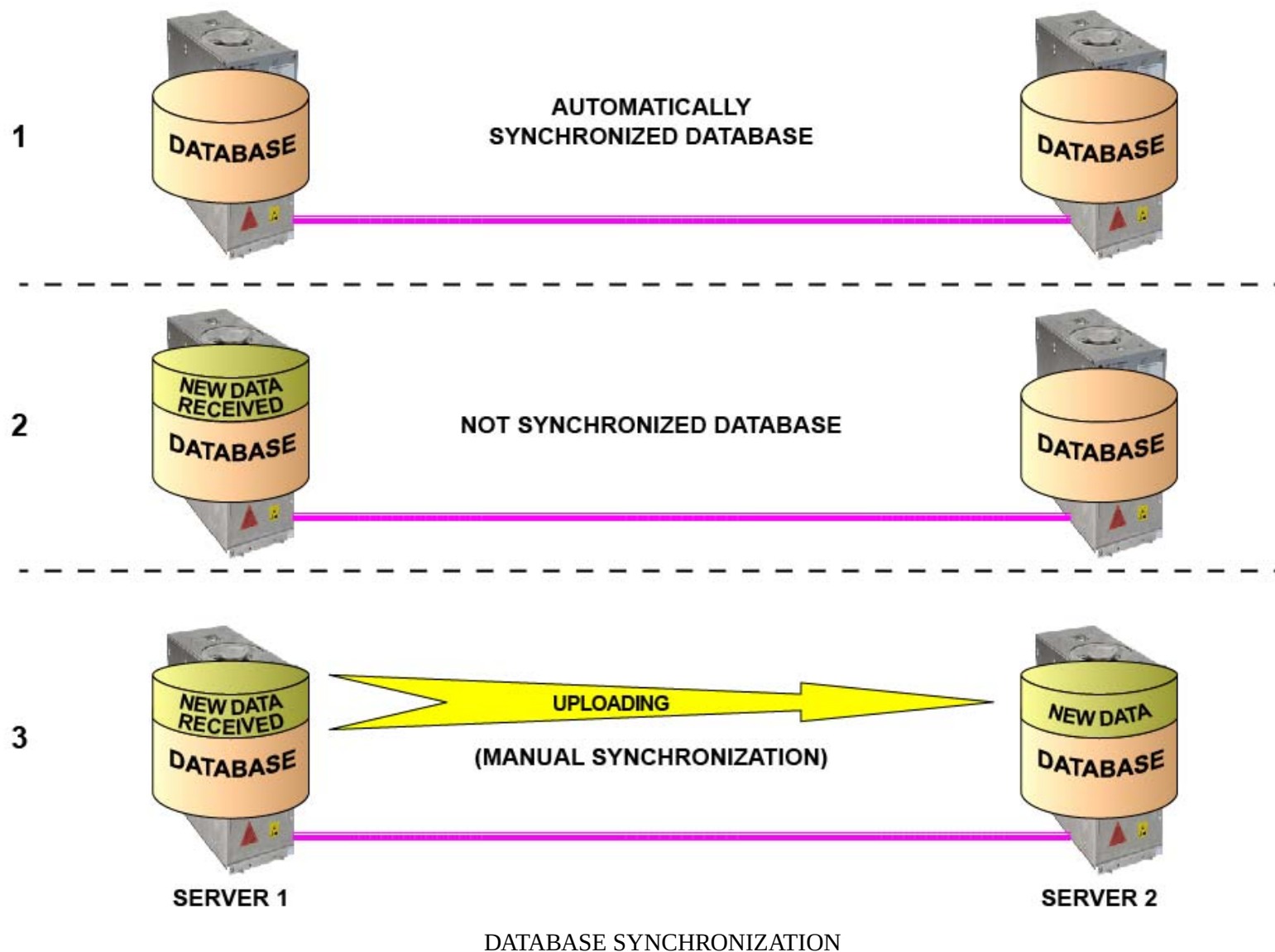
CONFIGURATION AFTER RESTORATION



A/C SOFTWARE MAINTENANCE OPERATIONS

Database Synchronization

The synchronization of two databases makes sure that the data content of the two servers databases is the same. It can be done manually or automatically. If a new data is added into the server 1 database, this new data will be copied and uploaded into the server 2 database. If a data is removed from the server 1 database, it will be deleted from the server 2 database.



LIGHTS PRESENTATION

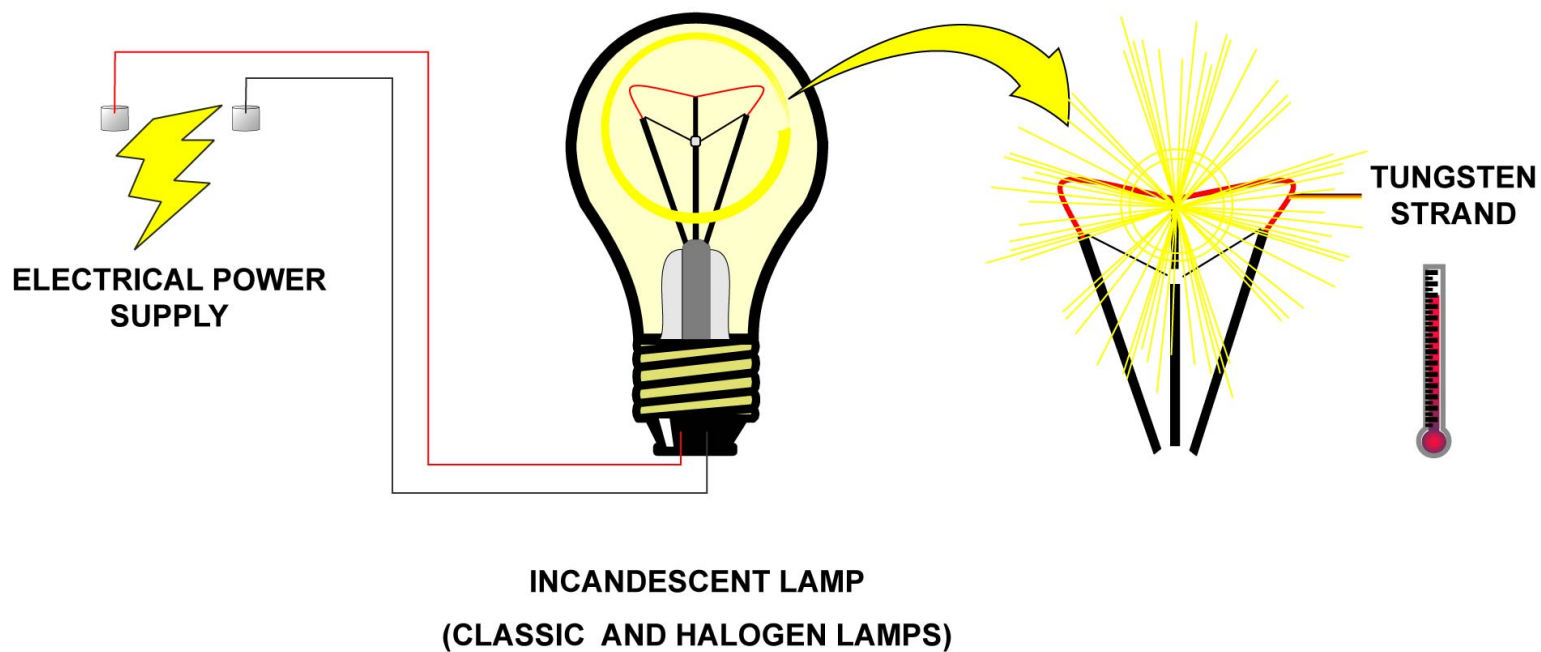
Introduction

The classical method to make light is to use incandescent lamps. The classic and halogen lamps are incandescent lamps, which use electricity to increase the temperature of a strand, generally in tungsten, to give light. Most of the energy is wasted as heat (approximately 95%).

On a 21st century aircraft like the A380/A350, technologies with better performances, less energy consumption and smaller maintenance costs, are now used in the lighting system, such as:

- The High Intensity Discharge (HID) technology, and
- The Light Emitting Diodes (LED) technology.

THE INCANDESCENCE PRINCIPLE



INTRODUCTION



**LESS
ELECTRICAL POWER
CONSUMPTION**



**REDUCED
MAINTENANCE
COSTS**



INTRODUCTION

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LIGHTS PRESENTATION

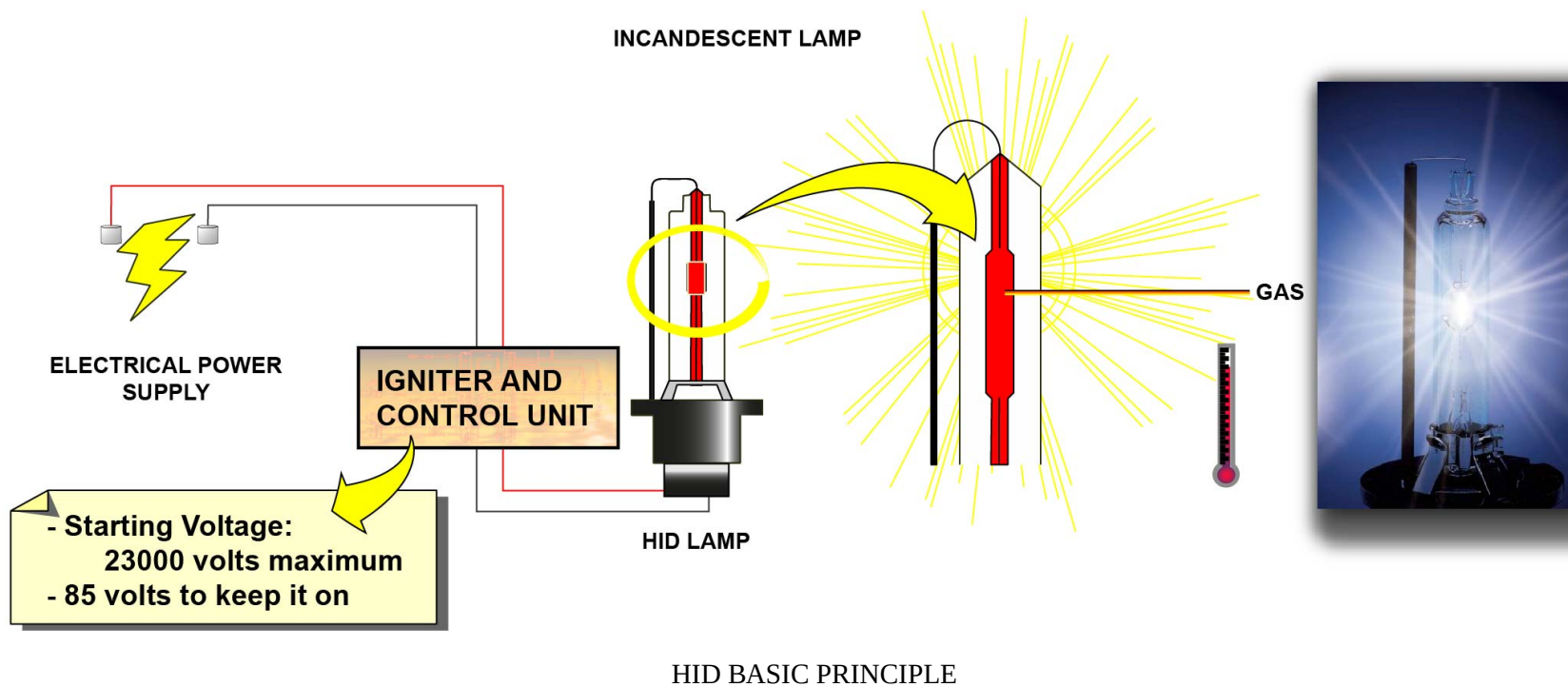
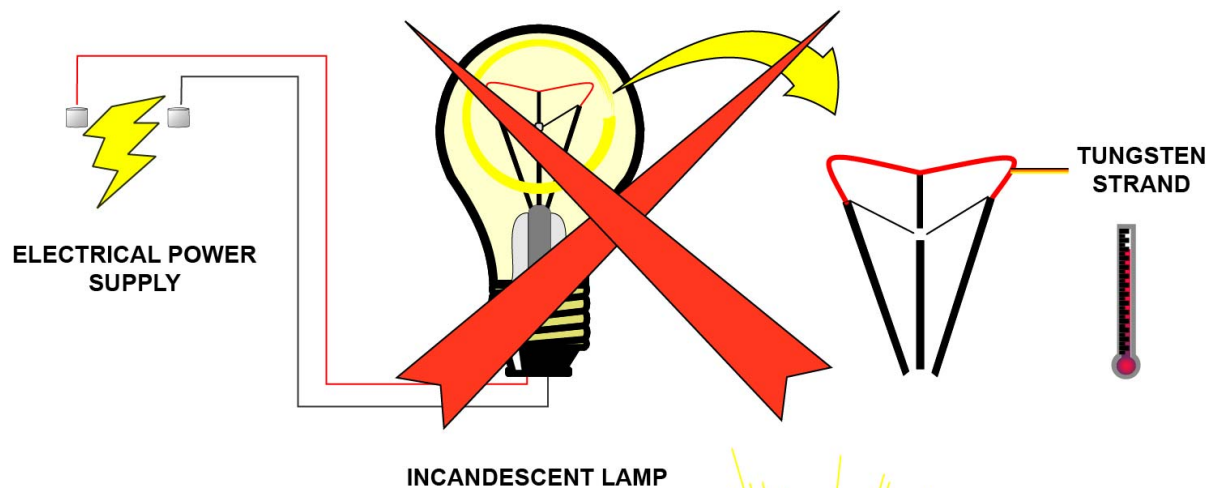
HID Basic Principle

The High Intensity Discharge (HID) lamp is a gas-discharge lamp. In this type of lamps, the temperature of a gas is increased to give light (as a difference from incandescent lamps in which the temperature of a strand is increased).

Like all gas-discharge lamps, HID lamps also have special electrical requirements:

To start an HID lamp, there must be a high voltage surge to generate an arc in the gas. When the lamp is started, the gas has less resistance, thus the power supply must be adjusted to agree with this decreased resistance. If not, the lamp will use more and more power and will burn itself out quickly.

A specific igniter and control unit is used to make the lamp wattage agree with the electrical requirements. It supplies the necessary starting voltage and then controls the subsequent flow of current to the lamp, and thus adjusts the power. To generate the arc in the 50 W Xenon metal halide HID lamp, it is necessary to have a starting voltage with a maximum of 23000 volts and only 85 volts to keep it on.



XN113211 - X04NTT0 - XM33P1NEWTECH01

LIGHTS PRESENTATION

LED Basic Principle

An LED converts input electrical energy into output optical radiation in visible, ultraviolet or infrared light rays. The type of light rays obtained is related to the semiconductor material used, and not to the color of the epoxy lens. Visible colors include red, yellow, orange, amber, green, blue/green, and blue.

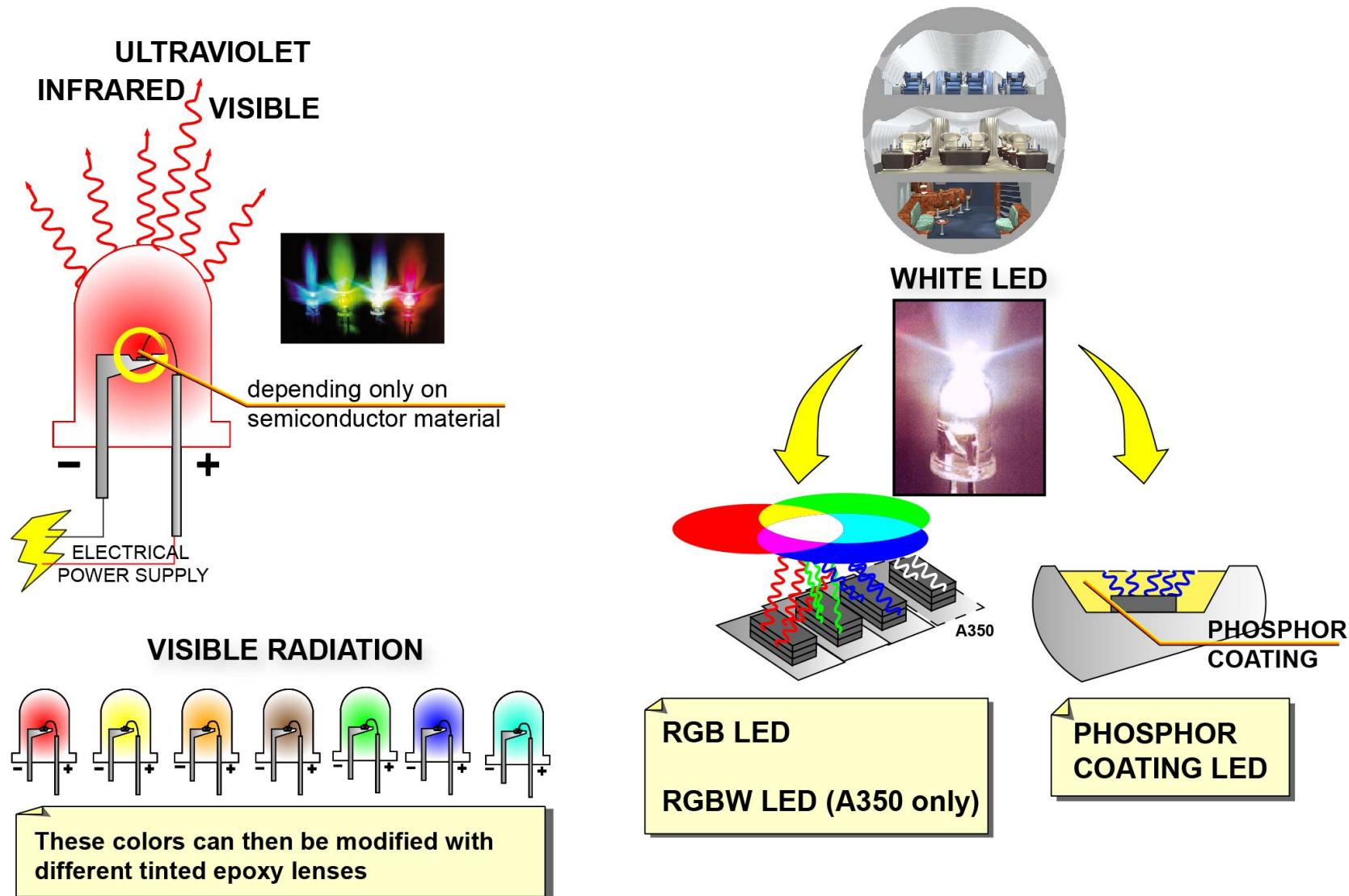
These colors can then be modified with different tinted epoxy lenses, although the light intensity will be decreased.

White color LEDs can be made by two methods:

- With the first method, red, green and blue LED chips are put together in one discrete package or cluster LED lamp, called RGB LED..

For the A350, a white LED chip can be added to provide RGBW LED.

- The second method is to use phosphor coatings, which will be excited by colored or ultraviolet LED chip photons. This method is simpler and has a better color integrity than the mixing of three colors.



LED BASIC PRINCIPLE

LIGHTS PRESENTATION

Benefits

There are different benefits when you use HID and LED lamps, and not incandescent lamps:

Benefits related to the electrical efficiency:

- Less heat release because there are almost no infra-red emissions,
- Less power consumption.

Benefits related to the light quality:

- Less color deterioration, because there is no ageing of the bulb,
- HID and LED lights agree better with the eye sensitivity and is brighter than the light from incandescent lamps,
- One 50 W Xenon metal halide HID lamp on the A380, with 5300 lumens, is equal to one 300 W halogen lamp.

Benefits related to the size and vibrations:

- Less sensitive to vibrations because there is no strand,
- Smaller lamps give an optimized adaptation to aircraft contour.
- HID lamps have a much longer lifetime than incandescent lamps. On average, the HID lamp lifetime is 20 times longer than incandescent lamps, approximately 4000 operating hours.
- The light from HID lamps is whiter than the light from incandescent lamps, thus the HID light seems to be brighter than the other lights.
- LED lamps have a much longer lifetime than incandescent lamps. On average, the LED lamp lifetime is 100 times longer than incandescent lamps. A LED can keep 50% of its initial brightness after 200,000 hours.
- There are no more colored filters. Incandescent bulbs waste a large quantity of their energy in light that is stopped by the colored lenses or filters. LEDs supply 20% of their energy as colored light.

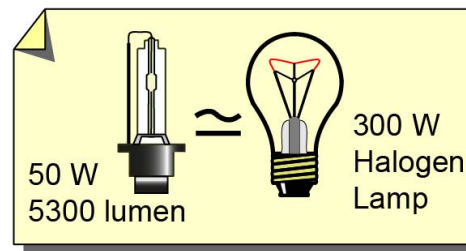


HID LAMPS



LED LAMPS

HID & LED LAMPS vs INCANDESCENT LAMPS



ELECTRICAL EFFICIENCY

Less heat
release

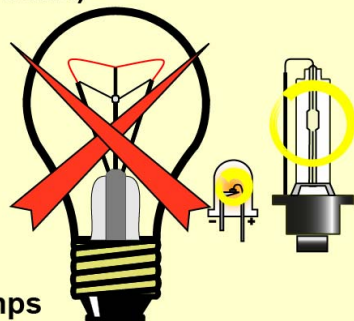


Less power
consumption



VIBRATION AND SIZE

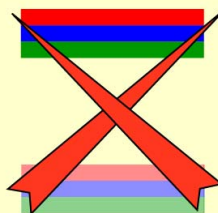
Less vibration
(no more strand)



Smaller lamps

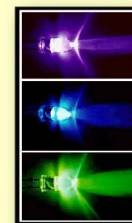
LIGHT QUALITY

Less color
deterioration



Ageing

HID and LED lights are
brighter and agree better with
the eye sensitivity


LED
Lamps

HID
Lamps

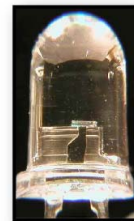
Incandescent
Lamps

BENEFITS



**HID LAMPS vs
INCANDESCENT
LAMPS**

HID LAMPS



**LED LAMPS vs
INCANDESCENT
LAMPS**

LED LAMPS

Longer Lifetime: 4000 operating hours



Longer Lifetime: 200 000 operating hours



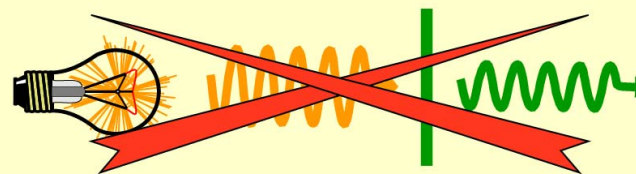
HID lamps light is whiter



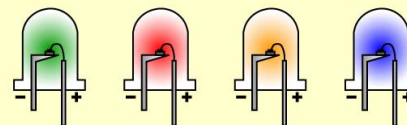
HID Lamps

Incandescent Lamps

No More Colored Filters



LED EMITS COLORED LIGHT



BENEFITS

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LIGHTS PRESENTATION

Application

The A380 and A350 lighting systems use these two new technologies.
HID lamps are very good for the lighting of large areas. They are used:

- In Wing and Engine scan lights,
- In Taxi, Runway Turnoff, Landing and Take-Off lights,
- In Logo lights,
- In Taxi Camera lights,
- In Cargo loading area lights.

LED lamps are used:

- In the navigation lights,
- In the beacon lights (A350 only),
- Several applications in the cabin such as the LED spotlights, reading lights, passenger signs, exit signs, etc.

There is also a new full LED concept in the cockpit of the A380 and A350.



HID
very good for lighting of large areas

Wing and Engine scan lights



Taxi, Runway Turnoff and Take-Off and Landing lights



Logo lights



Taxi camera lights



Cargo loading area lights



APPLICATION



APPLICATION

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LIGHTS: MAINTENANCE OPERATIONS

HID Precautions, Rules And Procedures

HID lamps emit a small quantity of UV rays, when they are on. Most of these UV rays are stopped by the outer tube. As a precaution:

- It is recommended to put a protection on the parts of your body that receive direct light at a small distance from the bulbs for long periods of time, to prevent sunburn (like with halogen bulbs).
- Wear safety UV glasses to prevent risks of conjunctivitis.

In operation, the temperature is 800°C on the outer tube, and 240°C maximum on the lamp base, thus:

Do not touch an HID lamp in operation. After you set the HID lamp to OFF, wait for 3 minutes to let the bulb become cool. Disconnect it before you start a removal procedure. Put a special note in position to tell persons of this.

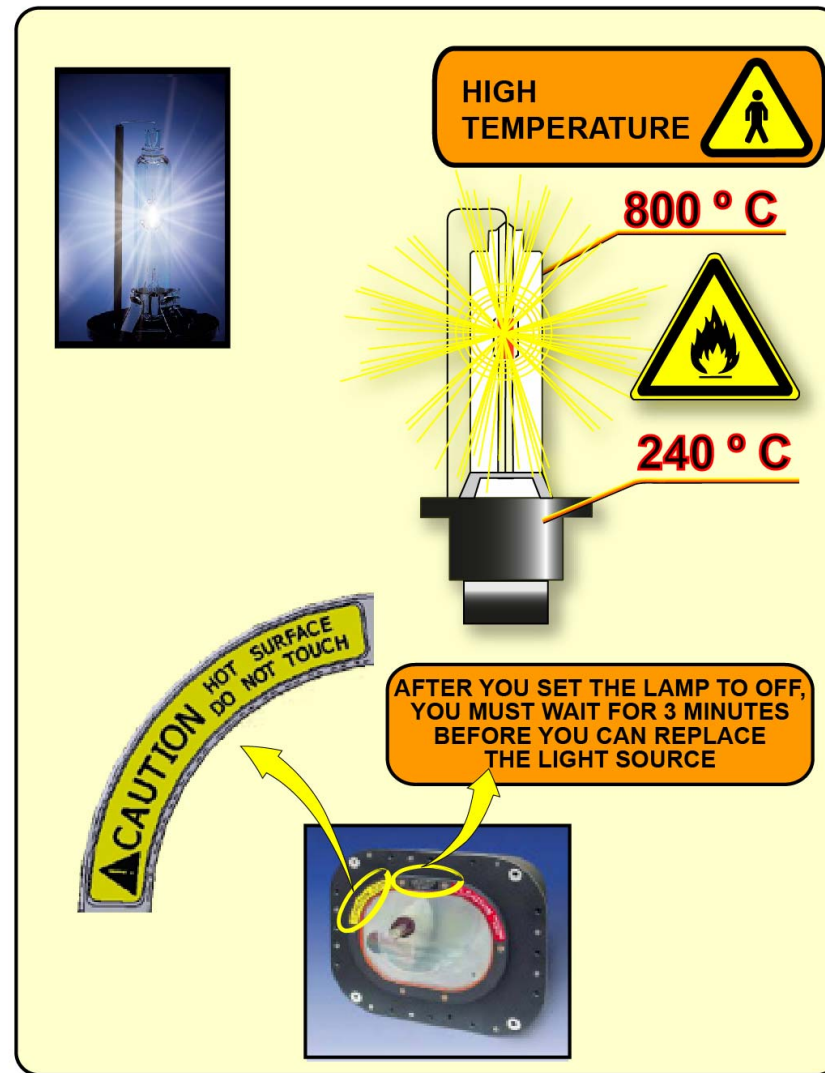
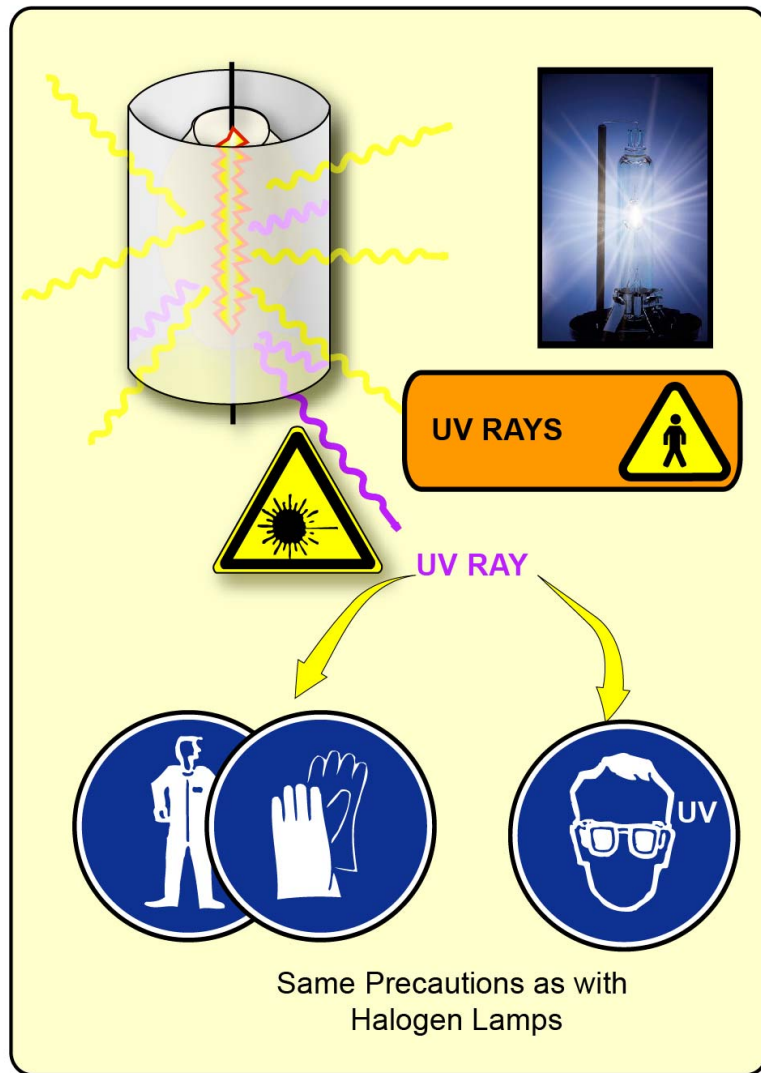
The operation pressure in HID bulbs is approximately 50 bar (725 PSI) in hot state and 3.7 bar (53.4 PSI) in cold state, which prevents risks of explosion. Wear safety glasses and gloves when the bulbs are on and when the bulbs are off.

Be careful when you touch HID lamps: the inner arc tube contains 0.6 µg of mercury. If the arc tube breaks, it is possible that the operator will get some mercury through his skin. Mercury is poisonous. Always wear safety gloves.

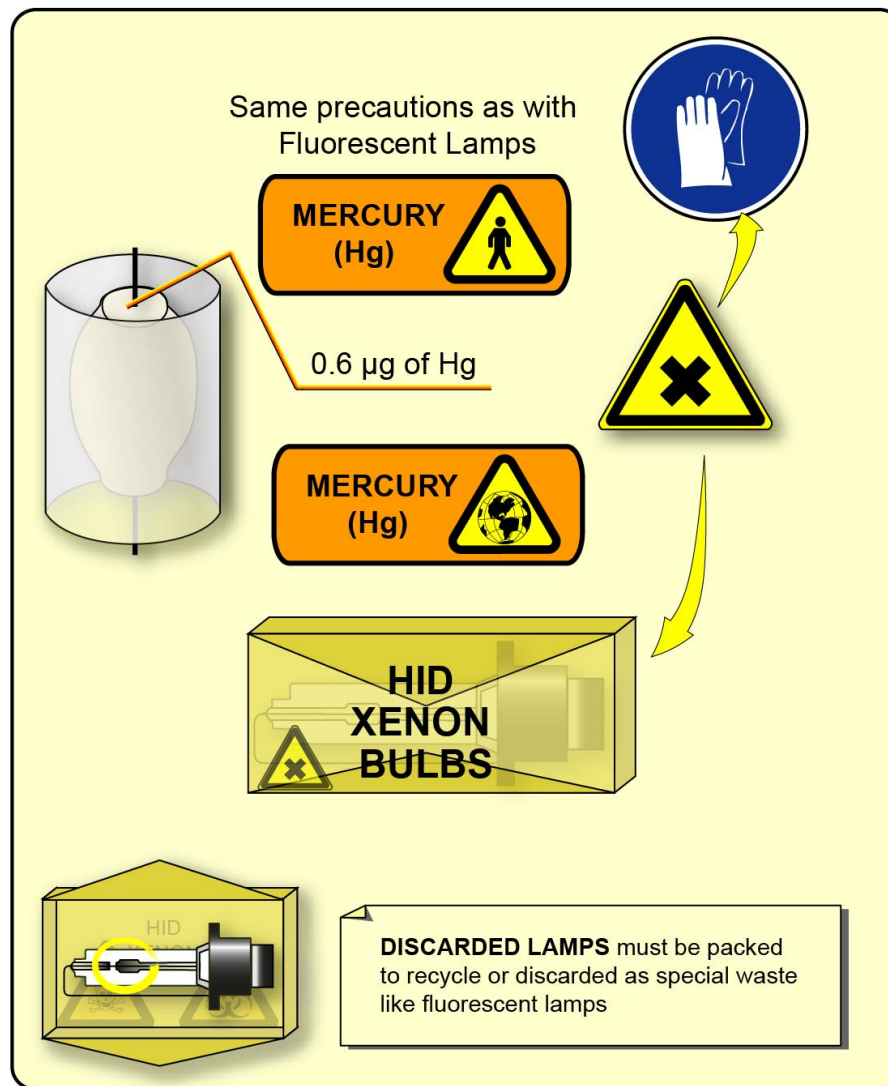
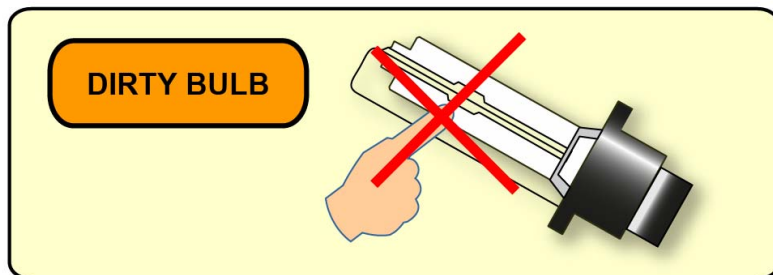
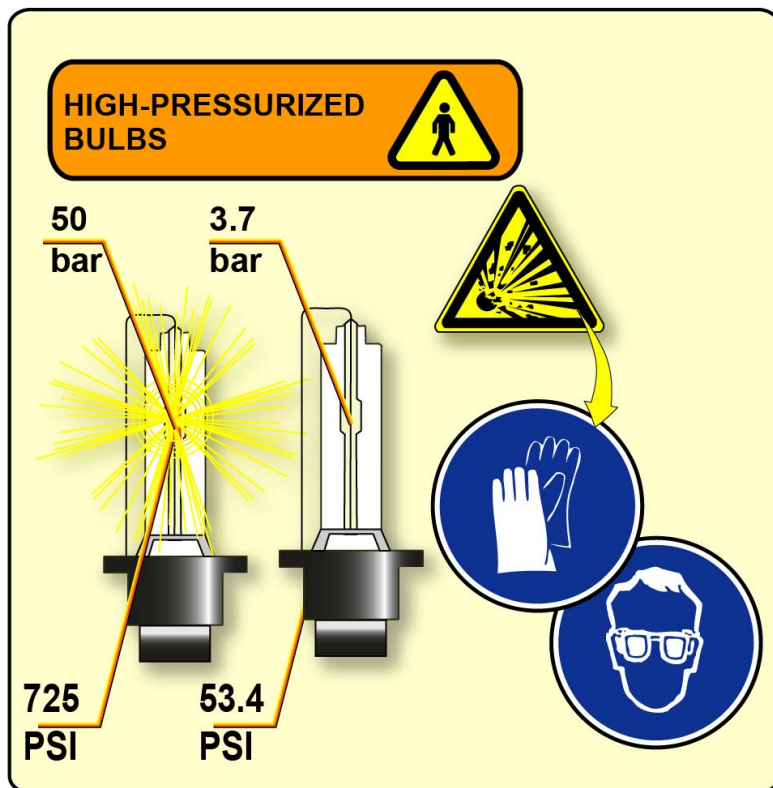
Mercury is also a dangerous material to the environment. Thus spare lamps are carefully packed to prevent breakage. Discarded lamps, which are defective or worn, must always be put back in their packaging and sent to an organism authorized to recycle this type of material, or discarded as special waste like fluorescent lamps.

Do not touch the bulb directly with your fingers.

UV: Ultra-Violet



HID PRECAUTIONS, RULES AND PROCEDURES



HID PRECAUTIONS, RULES AND PROCEDURES

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LIGHTS: MAINTENANCE OPERATIONS

LED Maintenance Activities

LED lamps have normal cleaning procedures like other lamps. LED bulbs cannot be replaced individually. The complete lamp must be replaced. No specific tool is necessary for the removal/installation of this type of lamp.

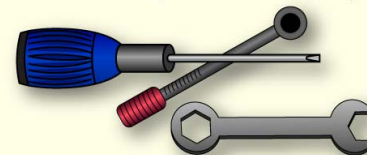
**NORMAL
MAINTENANCE
ACTIVITIES**

REPLACEMENT


**LED bulbs
are not individually replaced**

TOOLING

No specific tooling


LED MAINTENANCE ACTIVITIES

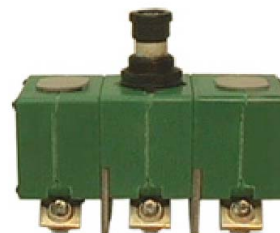
SSPC AND PROGRAMMABLE RCCB PRESENTATION

Introduction

The classical circuit breakers, that use electromechanical technology, are designed to trip the electrical supply to a dedicated system and to give it protection at the specified current limit. This technology is frequently used, but its wiring protection function is not always satisfactory because some factors (e.g. dust particles, shock or vibrations) prevent it. Arcing of contacts also occurs. And it is necessary to do a physical check of the status of the circuit breaker and to manually trip and tag it for maintenance operations.

All these problems do not occur with the new Solid State Power Controller Technology and the programmable Remote Control Circuit Breakers.

These two technologies are parts of the main electrical distribution system.

USUAL CIRCUIT BREAKERS

SENSITIVE TO:

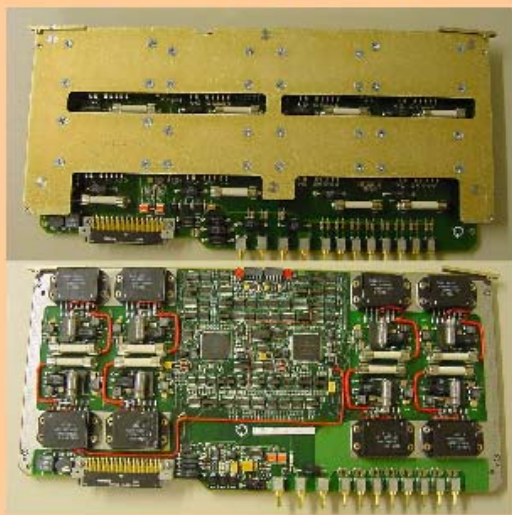
- DUST,
- VIBRATION
- ARCING
- AGEING

NO REMOTE CONTROL
INTRODUCTION



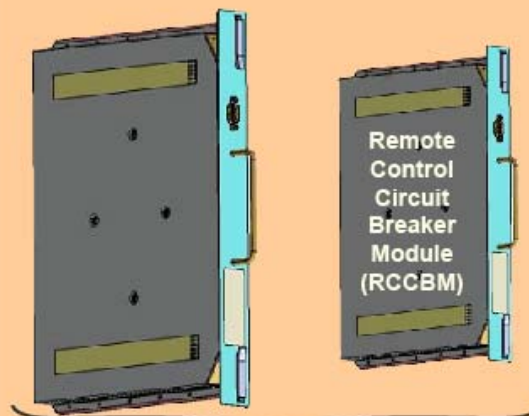
Solid State Power Controller (SSPC) Technology

SSPC for loads < 15A



Programmable Remote Control Circuit Breakers (RCCB)

RCCB for loads > 15A



A380

A350

MAIN ELECTRICAL DISTRIBUTION SYSTEM

INTRODUCTION

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SSPC AND PROGRAMMABLE RCCB PRESENTATION

Solid State Power Controller Module

Basic Function And Benefits

The Solid State Power Controller (SSPC) Module is a combination of electronic and semiconductor devices in the same electronic card. The primary function of the SSPC Module is to be a protection device for the aircraft wiring against overload, and a system power supply switch for technical operation and load management.

Thus, the SSPC technology is an alternative to the classical Electromechanical Technology and its combination of a Circuit Breaker and a relay. The SSPC technology uses a microprocessor to control the state of the power switch and adapt the SSPC trip threshold to the wire gage by Software programming in a single device.

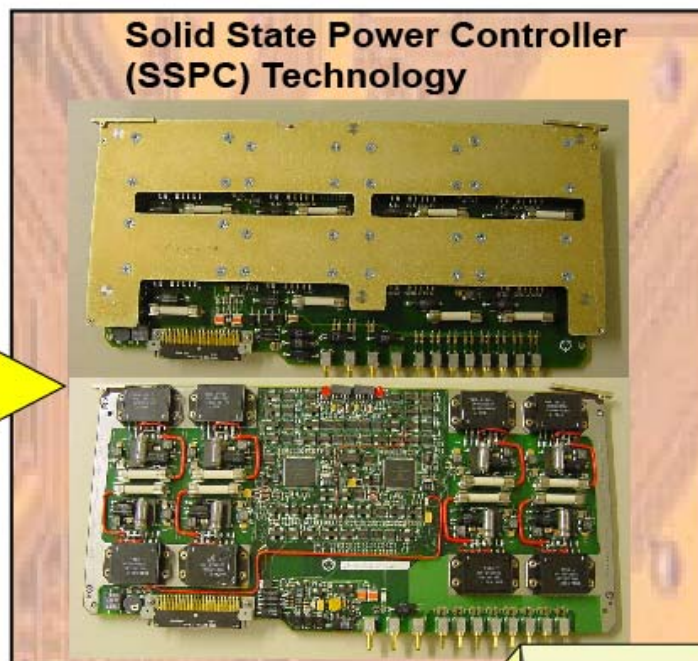
The advantages of SSPC technology are:

- Programmable rating,
- Data bus controllable,
- Fast switching with no arcing of contacts,
- BITE functions.

PROTECTION DEVICE + SWITCHING = SSPC



CLASSIC



NEW

Benefits of this technology:

- Programmable Rating
- Data Bus Controllable
- Fast Switching
- BITE function

SOLID STATE POWER CONTROLLER MODULE - BASIC FUNCTION AND BENEFITS

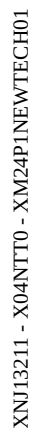
SSPC AND PROGRAMMABLE RCCB PRESENTATION

Solid State Power Controller Module (continued)

Principle

The switching function of an SSPC is an alternative to the classical relay logic.

The SSPC status can be displayed and controlled from the Power Distribution Maintenance Interface (PDMI on A380) or the Power Distribution Monitoring and Maintenance Function (PDMMF on A350).



SOLID STATE POWER CONTROLLER MODULE - PRINCIPLE

SSPC AND PROGRAMMABLE RCCB PRESENTATION

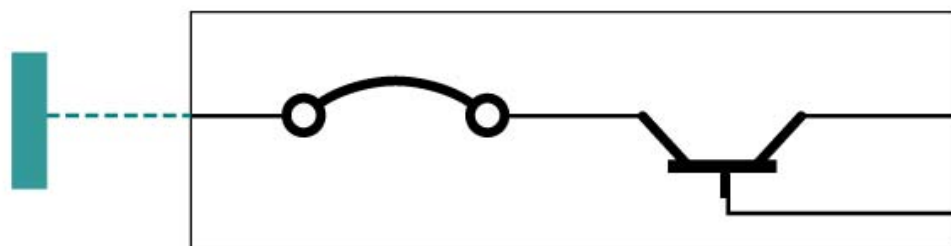
Solid State Power Controller Module (continued)

SSPC Channel Electrical Symbol

The SSPC Channel symbol is a combination of a circuit breaker and an electronic switch.

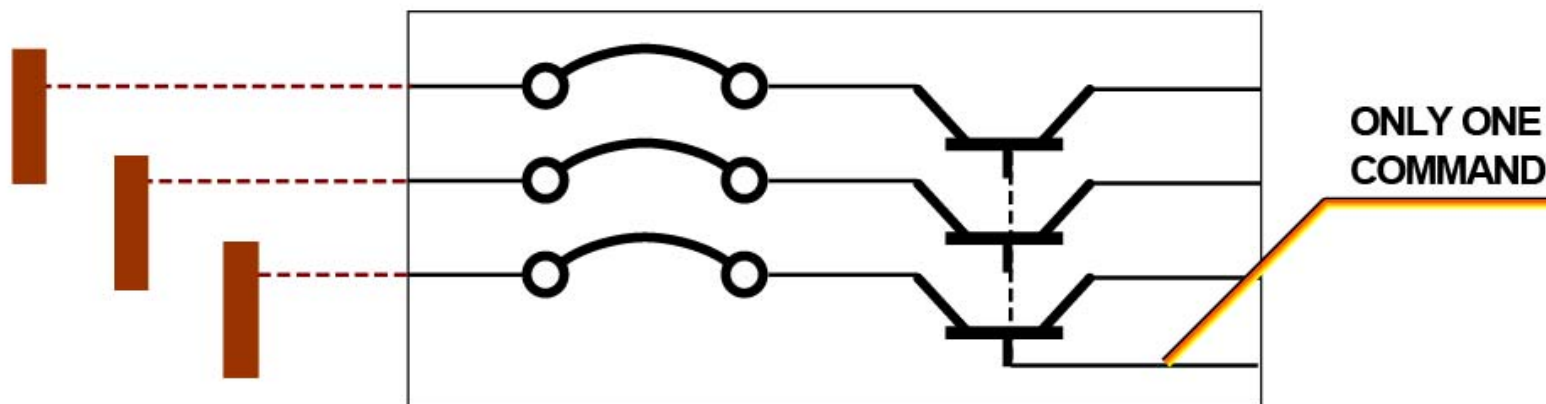
For a three-phase load, three SSPC Channel symbols are shown together and only one command is used.

Single-phase or DC SSPC Channel:



SSPCs based on semi-conductor technology

Three-phase SSPC Channels:



SOLID STATE POWER CONTROLLER MODULE - SSPC CHANNEL ELECTRICAL SYMBOL



XNJ13211 - X04NTT0 - XM24P1NEWTECH01



SSPC AND PROGRAMMABLE RCCB PRESENTATION

Solid State Power Controller Module (continued)

FUNCTIONS of SSPC LRM ELECTRONIC COMPONENTs

A SSPC LRM, Solid State Power Controller, is a set of electronic devices including:

- the local processing executed by dual micro controllers,
- 8 independent channels including switching, measurement and protection.

The redundant dual micro-controllers are used for

- periodic BITE execution
- the BITE results report, and
- Load and Trip Status monitoring.

These controllers send orders to eight independent channels.

Two LEDs, each one associated to a micro controller, provide fault indication on the front face of the LRM. LED flashes when the associated micro controller is working and do not flash when the SSPC LRM is faulty.

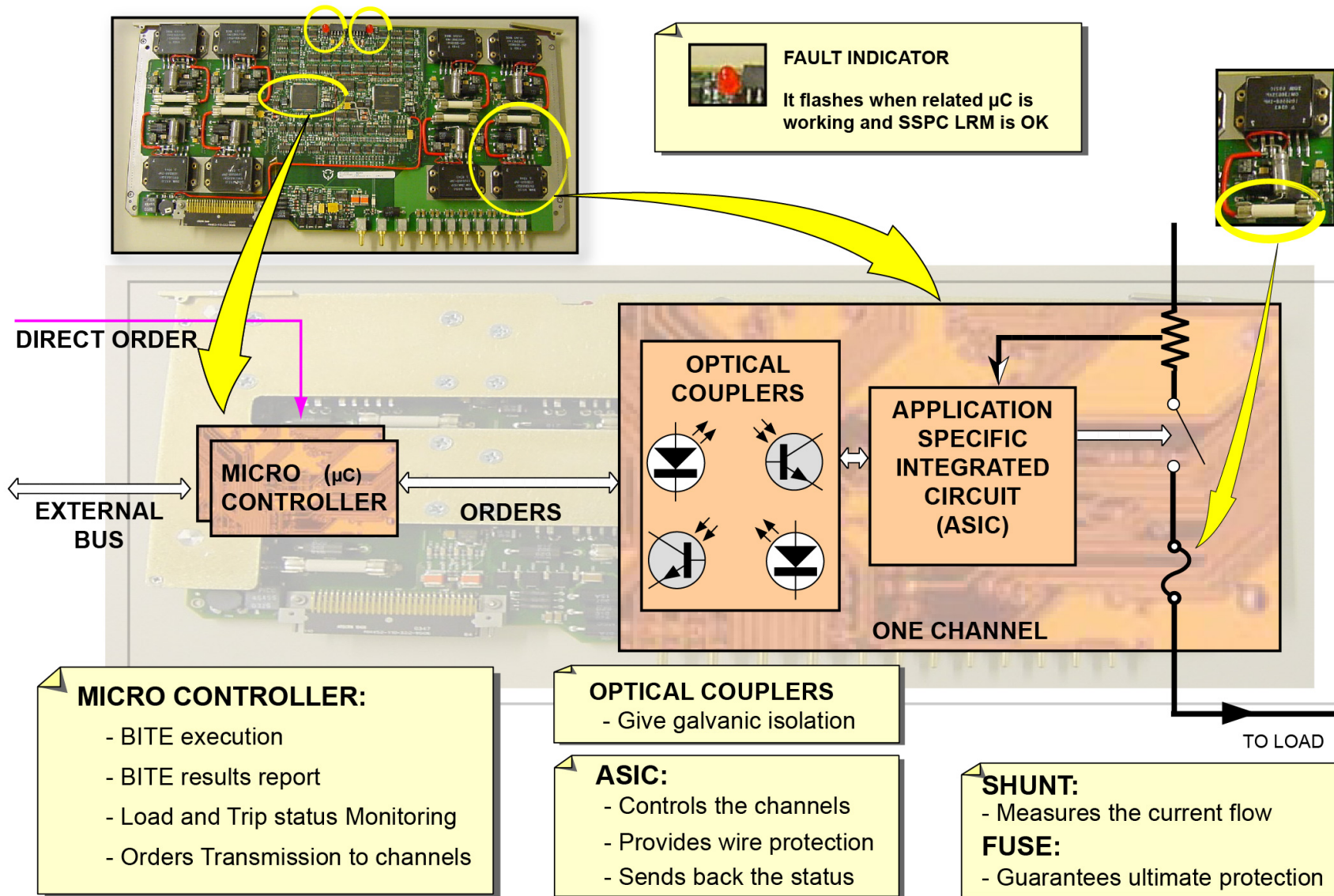
SSPC channels can be controlled through the external communication bus or directly by discrete signals for specific functions, in both cases, the order signals are always sent to the microcontroller.

Optical couplers give galvanic isolation and exchange data with the dedicated Application Specific Integrated Circuit (ASIC).

The ASIC:

- controls the channel,
- sends back the channel status to the micro controllers,
- and gives wire protection. The ASIC opens the power switch if the current is higher than the programmed rating.

Shunt in series with the power switch measures the current flow; and a fuse guarantees an ultimate protection in case of complete failure of the SSPC channel.



SOLID STATE POWER CONTROLLER MODULE - FUNCTIONS OF SSPC LRM ELECTRONIC COMPONENTS

SSPC AND PROGRAMMABLE RCCB PRESENTATION

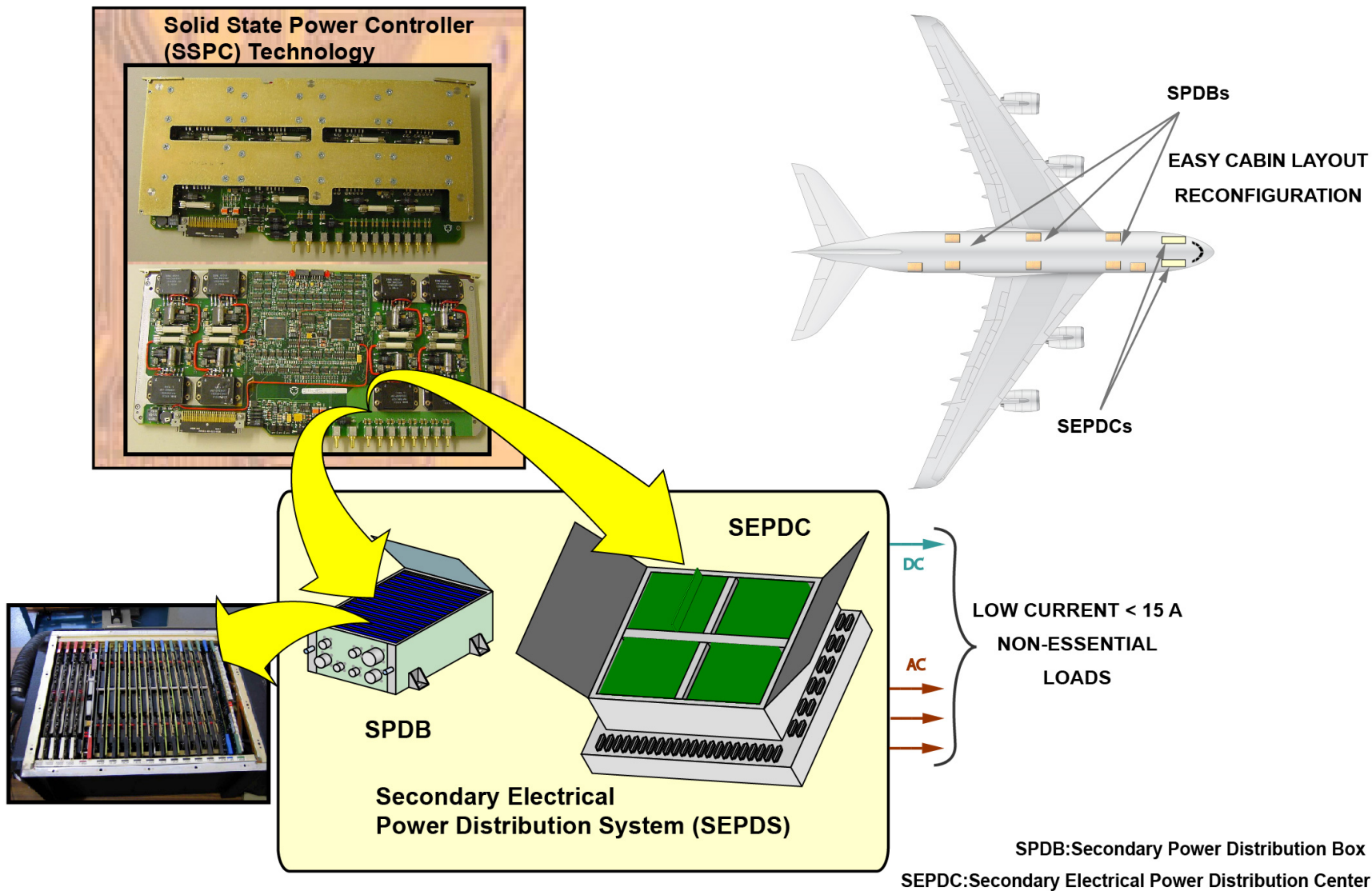
Solid State Power Controller Module (continued)

Application

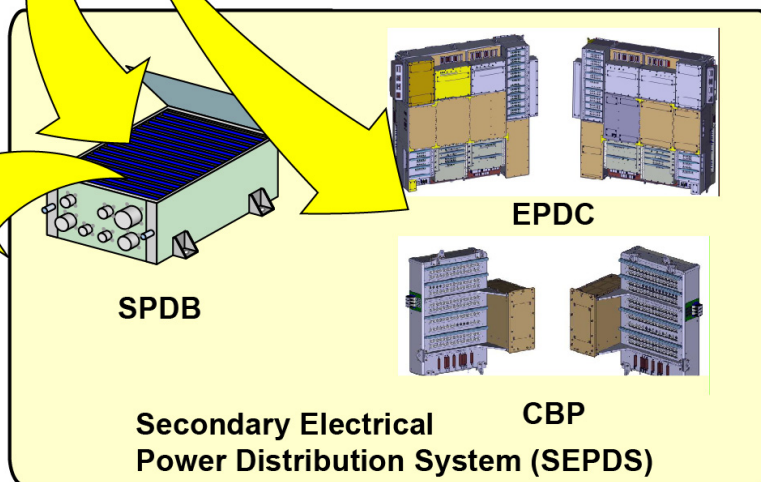
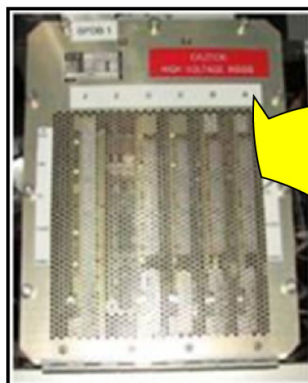
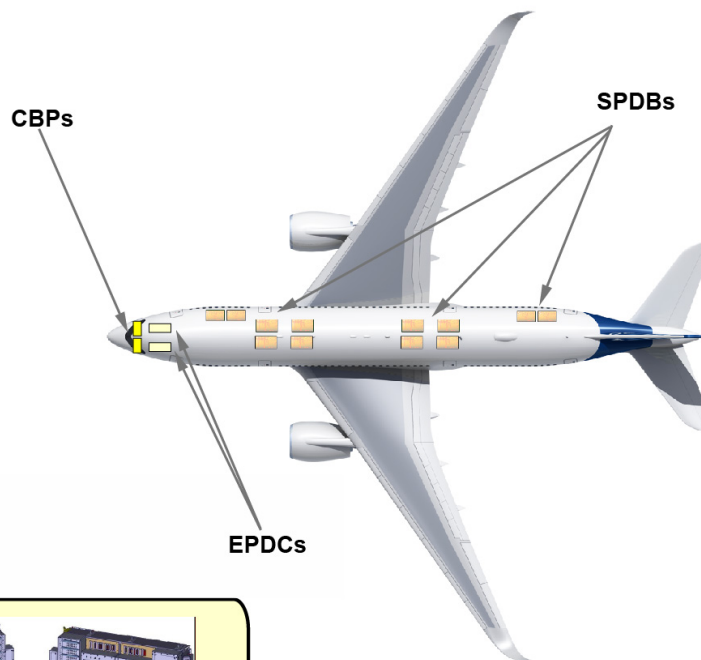
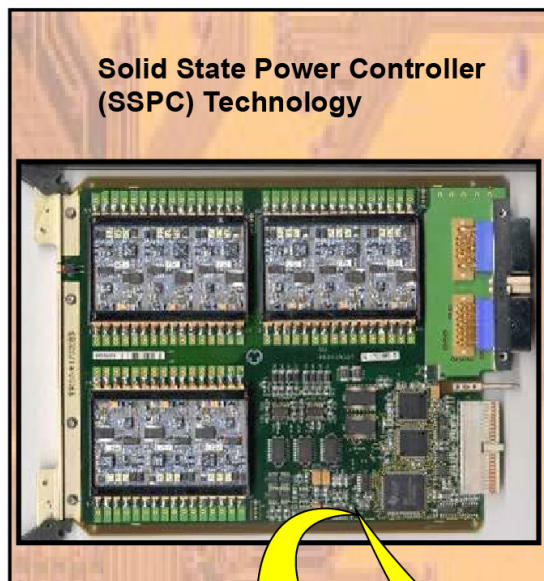
On the A380, the SSPC modules are used in the Secondary Power Distribution Boxes (SPDBs) or in the Secondary Electrical Power Distribution Centers (SEPDCs). On the A350, the SSPC modules are used in the SPDBs, the Electrical Power Distribution Centers (EPDCs) and the Circuit Breaker Panels (CBPs).

The Secondary Electrical Power Distribution System includes the SEPDCs and the SPDBs for the A380, and the EPDCs and the CBPs for the A350. Its functions are the protection and switching of low-current Non-Essential AC or DC Loads, which are not supplied in electrical emergency. The functions of the SEPDCs, EPDCs and CBPs are related to the management of the technical loads. The function of the SPDBs is related to the cabin loads.

The SEPDCs, EPDCs and CBPs are in the Main Avionics Bay and the SPDBs are in the Cabin and the Cargo Compartments. Each SPDB can have a special configuration (software programmable) related to the loads installed in each compartment. Thus, it is possible to change more quickly and the cabin layouts with better accessibility.



SOLID STATE POWER CONTROLLER MODULE - APPLICATION



SPDB: Secondary Power Distribution Box
EPDC: Electrical Power Distribution Center
CBP: Circuit Breaker Panel

SOLID STATE POWER CONTROLLER MODULE - APPLICATION

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SSPC AND PROGRAMMABLE RCCB PRESENTATION

Solid State Power Controller Module (continued)

SSPC LRM Description

The Solid State Power Controller (SSPC) technology is used for DC or AC currents switching and protection.

An SSPC LRM includes 8 independent SSPC channels. By software loading, each channel can be configured and programmed at specific ratings:

- Low-rating SSPC channels, which can be rated from 1 to 5 A,
- High-rating SSPC channels, from 7.5 to 15 A.

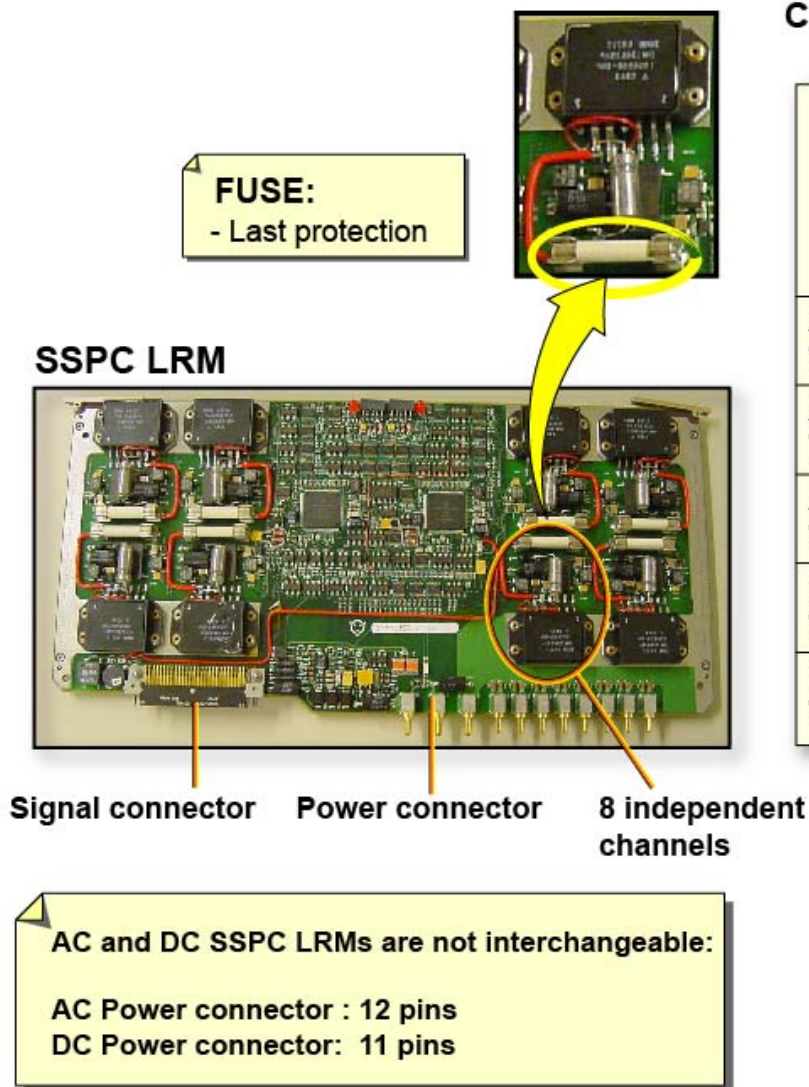
There are five different types of SSPC LRMs (three AC types and two DC types), to have different combinations of ratings on the same LRM. Two ejectors are used to remove the SSPC LRM from its chassis. The color of these two ejectors can be used to identify the SSPC LRM type (refer to the table shown on the slide).

A fuse is used as a last protection if a total failure occurs in the SSPC channel.

For three-phase load, we use three SSPC channels configured to operate as only one device.

The SSPC LRMs have a single power connector. A DC power connector has 11 pins and an AC power connector has 12 pins.

The AC and DC SSPC LRMs are not interchangeable.



CLASSIFICATION AND PROGRAMMABLE FUNCTION (A380 Typical design)

SSPC LRM Types	EJECTORS	Low Rating 1 to 5A Channels	High rating 7.5 to 15A Channels
AC SSPC LRM Type 1	■ ■	4	4
AC SSPC LRM Type 2	■ ■	5	3
AC SSPC LRM Type 3	■ ■	1	7
DC SSPC LRM Type 1	□ ■	3	5
DC SSPC LRM Type 2	□ ■	7	1



3 phase load = 3 SSPC Channels

SOLID STATE POWER CONTROLLER MODULE - SSPC LRM DESCRIPTION

SSPC AND PROGRAMMABLE RCCB PRESENTATION

Solid State Power Controller Module (continued)

Voltage check on open SSPC:

During the completion of wiring checks required on AFI/MP tasks some operators have measured residual voltages (up to 8V) at the output of opened and tagged SSPCs.

Furthermore, the level of residual voltage varied depending on the voltmeter used and the time the measure was taken.

Residual voltage at the output of opened and tagged SSPCs may lead to SEPDS AC &

DC LRM unjustified removals, since some operators may conclude that the SSPC is really not opened and tagged as commanded via the PDMI and is, hence, failed.

When opening and tagging one SSPC via the PDMI, ideally the current consumption of this SSPC should be 0 Amps.

However, as SSPCs are based on transistor technology, an undesirable leakage current

(or off-state current) will continue to flow through the SSPC.

Given enough time, this off-state current may charge capacitive loads to nominal line

voltages. In order to avoid this phenomenon, clamping circuits as the one shown in the slide are widely used in industry.

Indeed, when a SSPC is opened and tagged via the PDMI, the clamping circuit will be

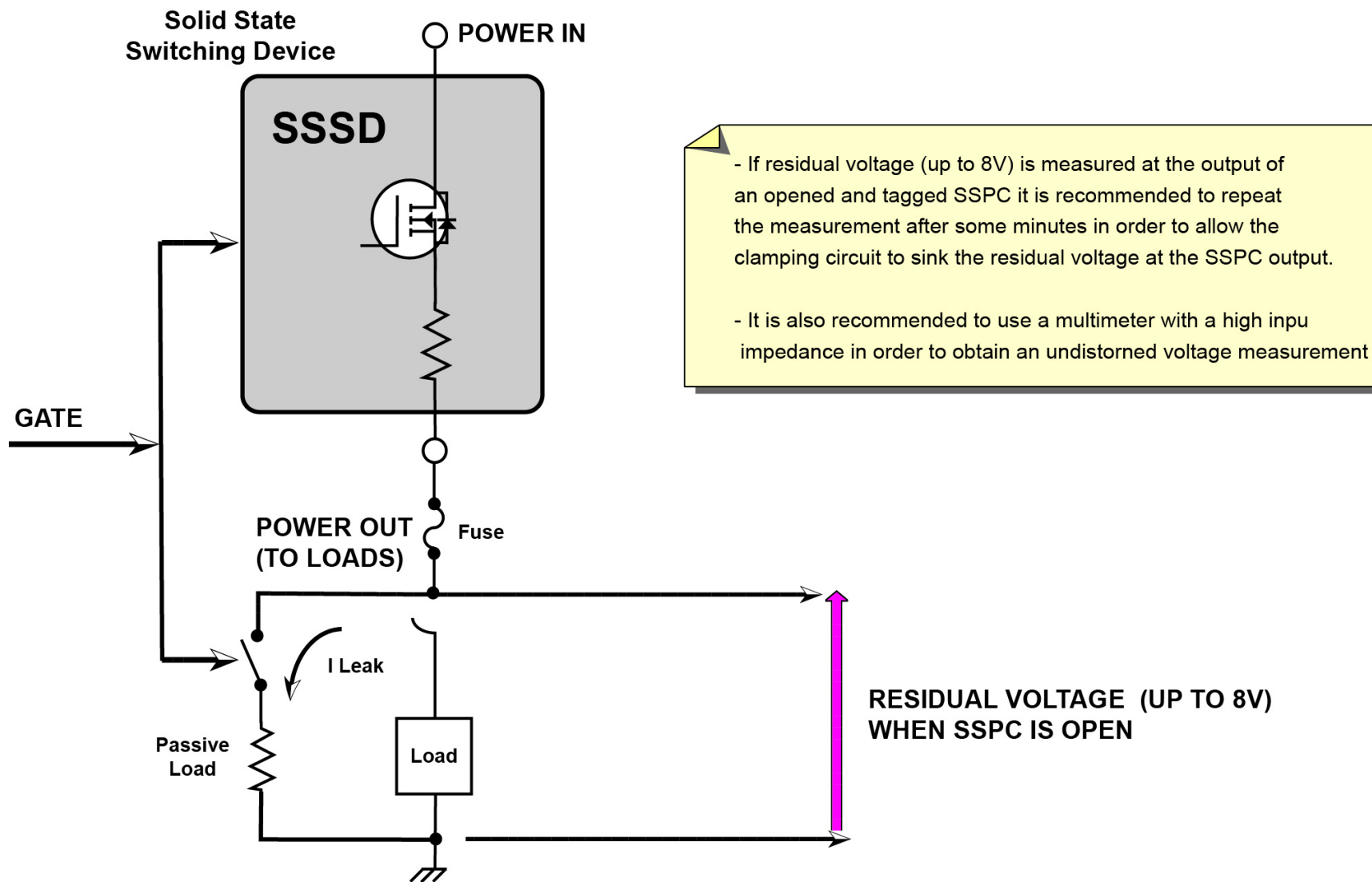
activated to sink the voltage at the SSPC output.

Clamping circuits used on A380 SEPDS SSPCs are not adapted to each specific load.

As a result, the settling time required for the residual voltage of some loads to sink may be long.

As a consequence, If residual voltage (up to 8V) is measured at the output of an opened and tagged SSPC, it is recommended to repeat the measurement after some minutes in order to allow the clamping circuit to sink the residual voltage at the SSPC output.

It is also recommended to use a multimeter with a high input impedance in order to obtain an undistorted voltage measurement.



SOLID STATE POWER CONTROLLER MODULE - VOLTAGE CHECK ON OPEN SSPC:

SSPC AND PROGRAMMABLE RCCB PRESENTATION

Programmable Remote Control Circuit Breakers

Basic Principle and Function

As in the classical Remote Control Circuit Breaker (RCCB), the programmable RCCB is a combination of a circuit breaker and a switching device in the same component. Its primary functions are:

- To do the switching of power to the consumers,
- To be a protection of the AC or DC wiring against short circuit.

The RCCB Module (RCCBM) gives protection to the RCCB against short circuit. To do this, it compares the current measured with the preprogrammed current limit.

The RCCBM is an electronic card with a programmable trip function hosted in a microprocessor.

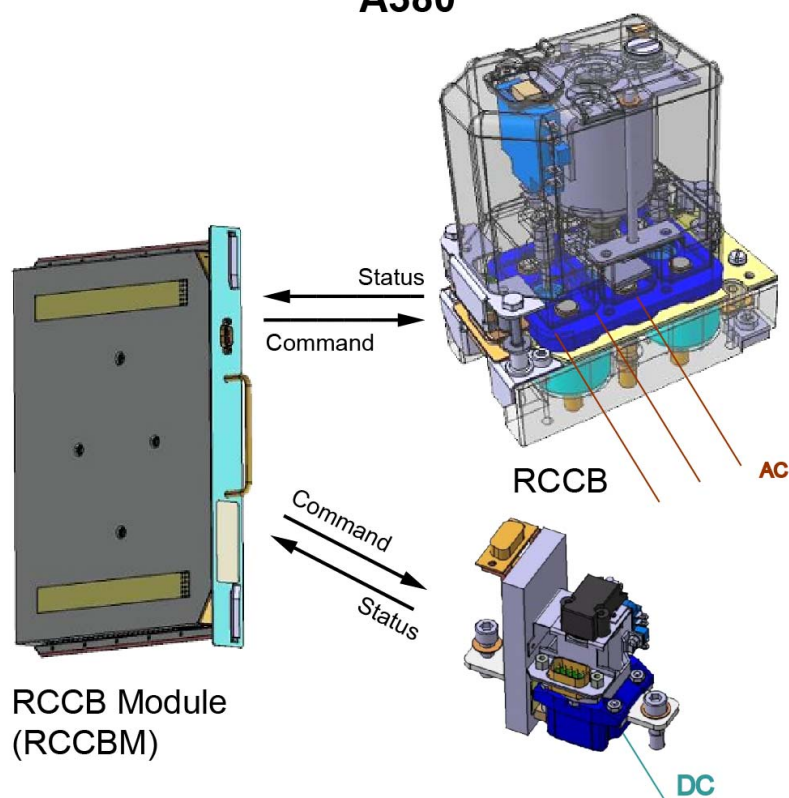
The RCCBM receives the status and opens/closes several AC and DC RCCBs at the same time.

The A350 RCCBs have two Printed Circuit Boards (PCB1/PCB2).

These PCBs have the same functions as an A380 RCCBM. Thus RCCBM are no more necessary on the A350.

Programmable Remote Control Circuit Breaker SWITCHING + AC/DC PROTECTION

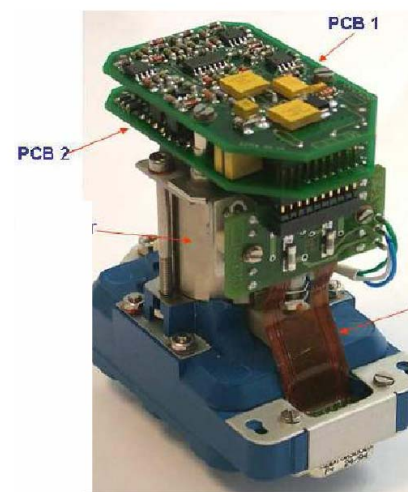
A380



RCCBM functions:

- Opens/Closes AC and DC RCCBs
- Trips RCCBs if an overcurrent occurs

A350



RCCB

RCCBM functions are included in the RCCB

PCB: Printed Circuit Board

PROGRAMMABLE REMOTE CONTROL CIRCUIT BREAKERS - BASIC PRINCIPLE AND FUNCTION

SSPC AND PROGRAMMABLE RCCB PRESENTATION

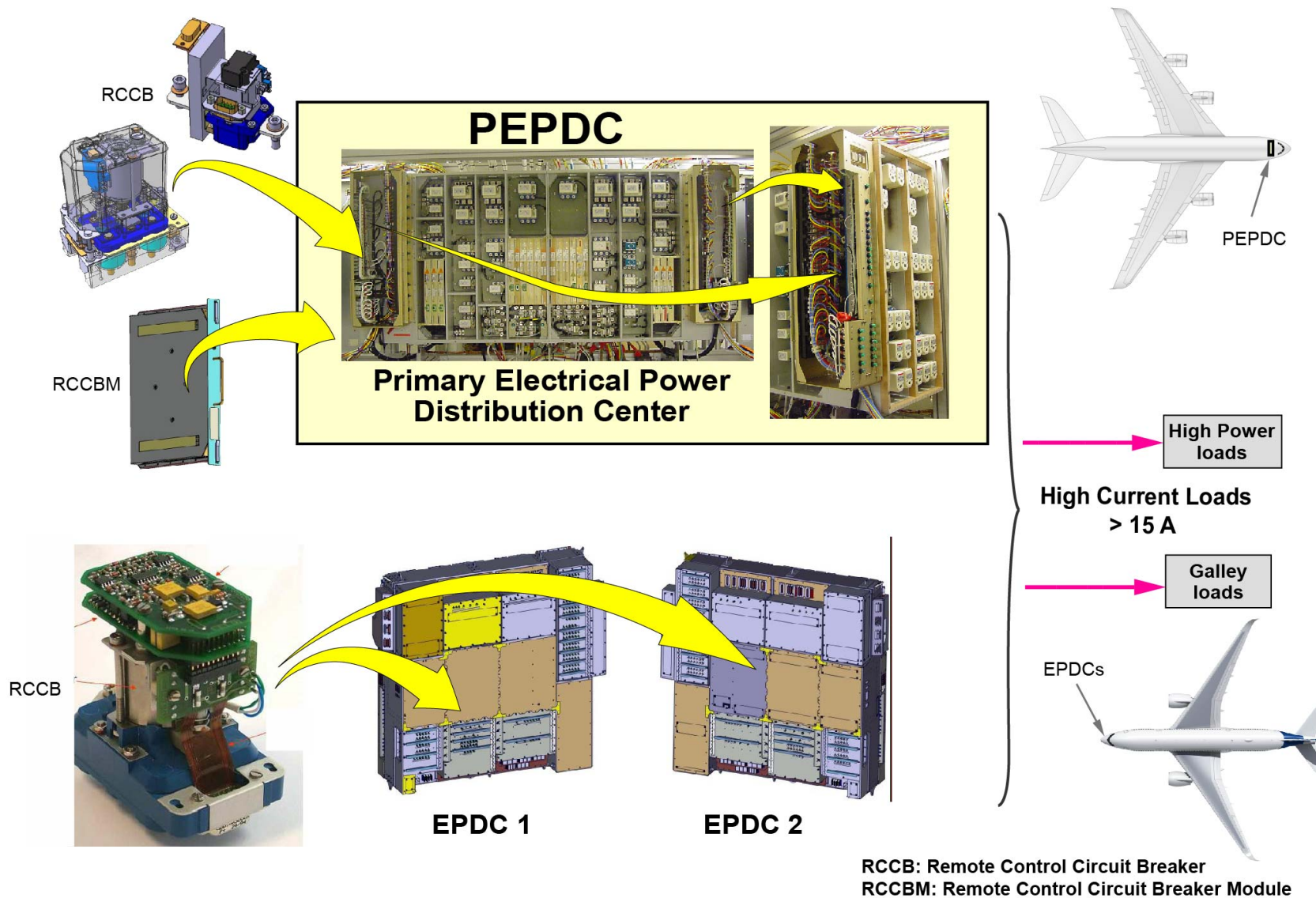
Programmable Remote Control Circuit Breakers (continued)

Application

The new RCCBs and RCCB modules are in the Primary Electrical Power Distribution Center (PEPDC) in the main avionics bay of the A380. On the A350, the RCCBs are in the Electrical Power Distribution Center (EPDC) in the main avionics bay.

They do the protection and switching functions for the supply of high-current loads. For example:

- Sub-busbars distributed into the SEPDS,
- Galley loads, and
- High consumers such as Thrust Reverser Actuators, Electro-Motor Pumps, Slat motor, etc.



PROGRAMMABLE REMOTE CONTROL CIRCUIT BREAKERS - APPLICATION

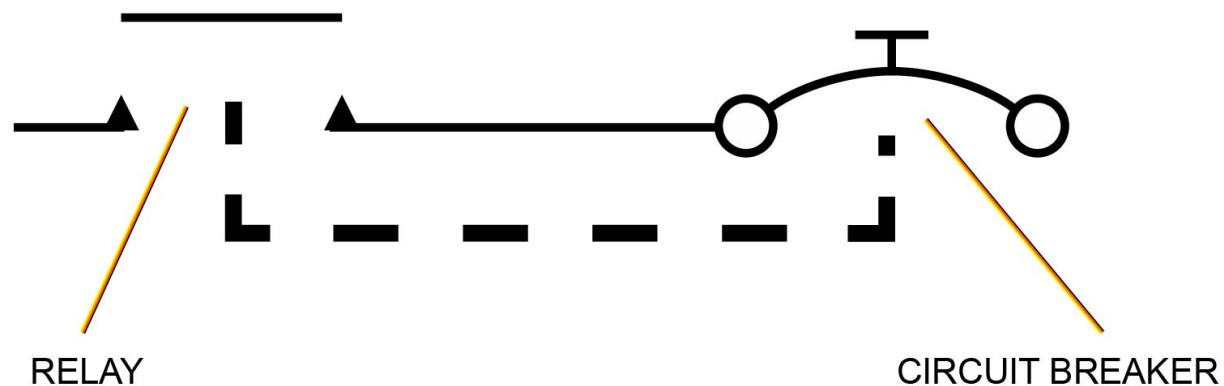
SSPC AND PROGRAMMABLE RCCB PRESENTATION

Programmable Remote Control Circuit Breakers (continued)

RCCB Electrical Symbol

The RCCB electrical symbol shows the two RCCB functions:
switching as a relay and wire protection as a circuit breaker.

Remote Control Circuit Breaker Electrical Symbol



PROGRAMMABLE REMOTE CONTROL CIRCUIT BREAKERS - RCCB ELECTRICAL SYMBOL

SSPC AND PROGRAMMABLE RCCB PRESENTATION

New Maintenance HMI

Because of the high number of protected loads, in the classical electromechanical technology, it was necessary to have a large panel and a large space available in the cabin to host the necessary quantity of C/Bs as maintenance Human-Machine Interfaces.

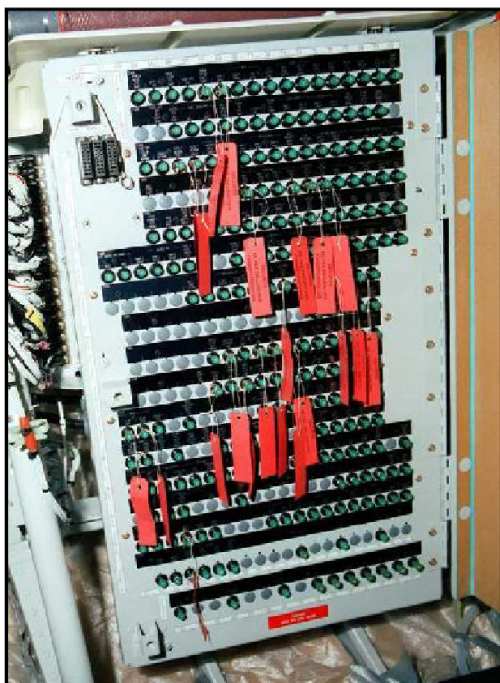
The new electrical maintenance Human-Machine Interfaces of these new technologies have better reliability and accessibility, and a smaller weight. The On-board Maintenance Terminal (OMT) and the Portable Maintenance Access Terminal (PMAT) are the primary interfaces used to manage the SSPCs and programmable RCCBs on the A380 and A350. All the data uploading or maintenance operations are done through these interfaces.

The Power Distribution Maintenance Interface (PDMI) also lets the technician control the SSPCs and Programmable RCCBs as conventional circuit breakers. They can be opened, reset and tagged to do maintenance procedures through dedicated hyperlinks or to isolate a system for dispatch.

Thus, the PDMI can be thought of as a virtual Circuit Breaker Panel. The equivalent of the PDMI on the A350 is the Power Distribution Monitoring and Maintenance Function (PDMMF).

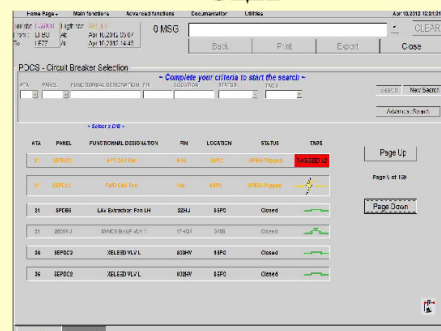
MAINTENANCE HUMAN-MACHINE INTERFACE (HMI)

CLASSICAL ELECTROMECHANICAL TECHNOLOGY



SSPC & Programmable RCCB TECHNOLOGY


OMT

PMAT

PDMI on A380

PDMMF on A350

better reliability, better accessibility and weight savings

OIT: On-Board Information Terminal
OMT: On-Board Maintenance Terminal
PMAT: Portable Maintenance Access Terminal
PDMI: Power Distribution Maintenance Interface
PDMMF: Power Distribution Monitoring & Maintenance Function

NEW MAINTENANCE HMI

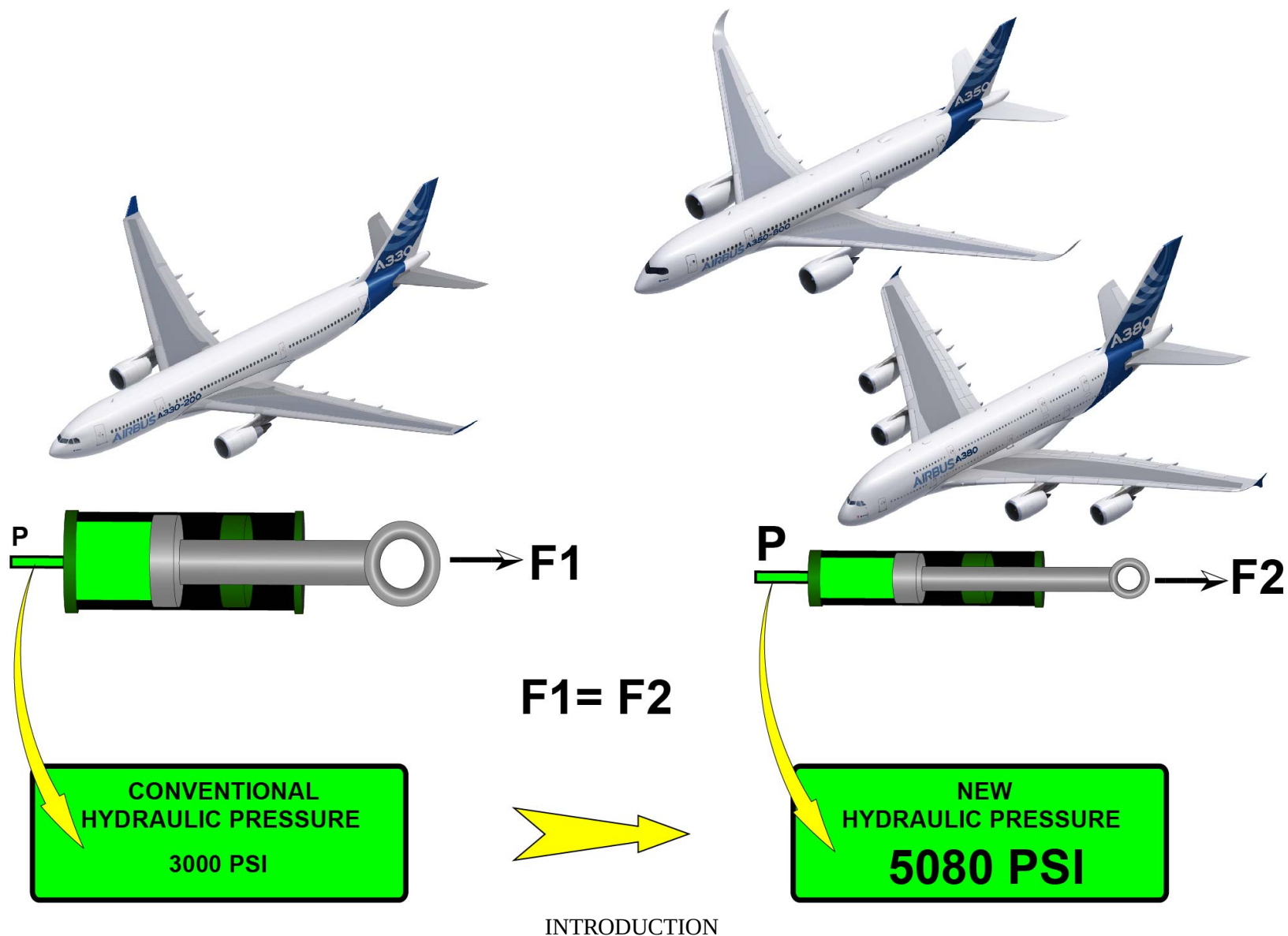
5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Introduction

The hydraulic pressure used on the A380 and A350 is 5080 psi, and not 3000 psi as on other aircrafts.

5080-psi actuators have 2 primary advantages:

- For the A350, they can supply the same force as 3000-psi actuators but they are smaller in size and weight.
- For the A380, because of the larger size of this aircraft, the actuators must supply more force. But 5080-psi actuators are smaller and lighter than 3000-psi actuators.



XN113211 - X04NTT0 - XM29P1NEWTECH01

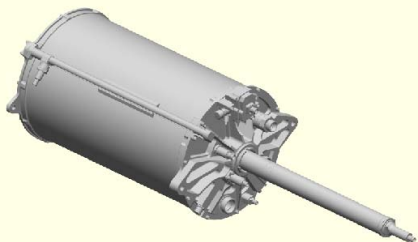
5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Generation

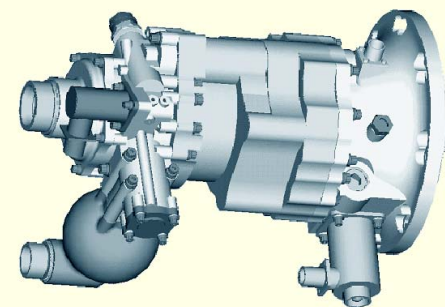
The 5080-psi Hydraulic Generation System on the A380 and A350 shows several novelties, such as:

- Bootstrap hydraulic reservoir (A350 only),
- Engine-Driven Pump Declutches,
- Heat Exchangers,
- Metal Bellow Accumulators.

**BOOTSTRAP
HYDRAULIC RESERVOIR
(A350 ONLY)**

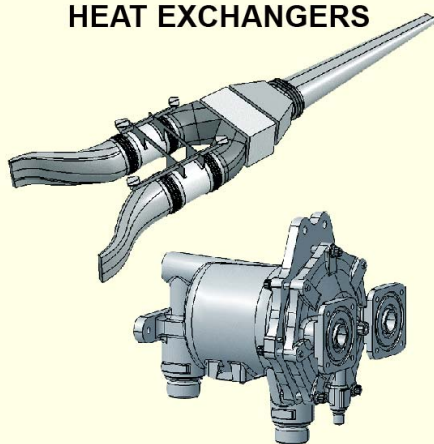


**ENGINE DRIVEN PUMP
DECLUTCH**



HYDRAULIC GENERATION NOVELTIES

HEAT EXCHANGERS



**METAL BELLOW
ACCUMULATOR**



HYDRAULIC GENERATION

5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Generation (continued)

A380 Basic Principle

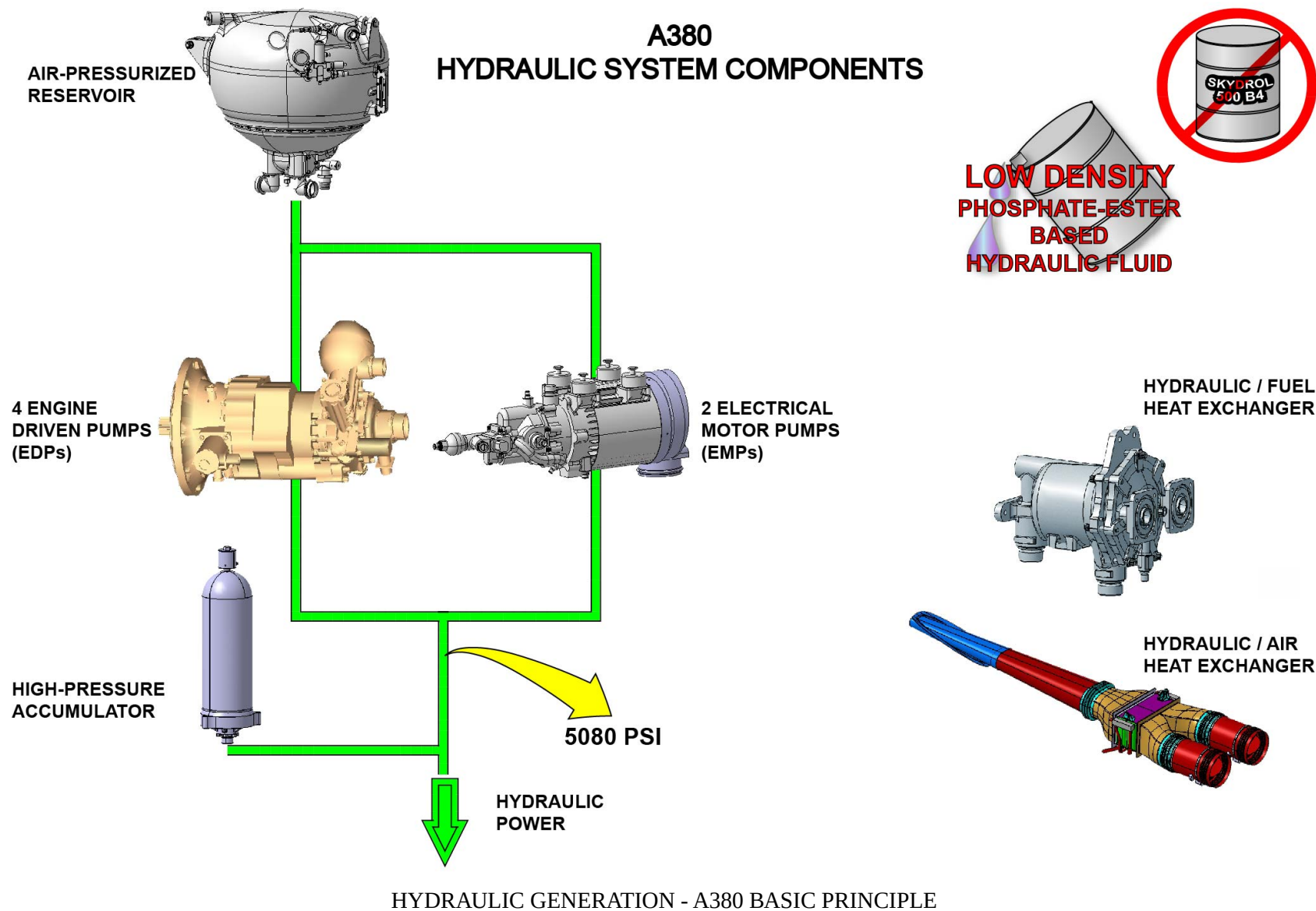
A high-pressure hydraulic system that operates at 5080 psi, and that has been used in military aircraft, is now used in large transport aircraft design like the A380. Its architecture is similar to a conventional hydraulic system and has:

- An air-pressurized reservoir,
- 4 engine-driven pumps, which are variable displacement pumps driven by the engine, to control the system pressure to 5080 psi,
- 2 electrical motor pumps, to supply an auxiliary hydraulic power source,
- A high-pressure accumulator.

In comparison with conventional hydraulic systems, there are two engine-driven pumps that operate in parallel on each engine. Also, because the natural cooling dissipation is not sufficient, heat exchangers are installed to keep the temperature of the hydraulic fluid in a satisfactory range.

To have a correct Hydraulic System performance, only Low-Density phosphate-ester based hydraulic fluids can be used in hydraulic systems with 5080-psi high-pressure lines. Skydrol LD4, Hyjet IVA+ and Hyjet V MP are the only qualified hydraulic fluids today for the A380.

It is not permitted to use SKYDROL 500B4, although it is an NSA 307110 compliant fluid.



XN113211 - X04NTT0 - XM29P1NEWTECH01

5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Generation (continued)

A350 Basic Principle

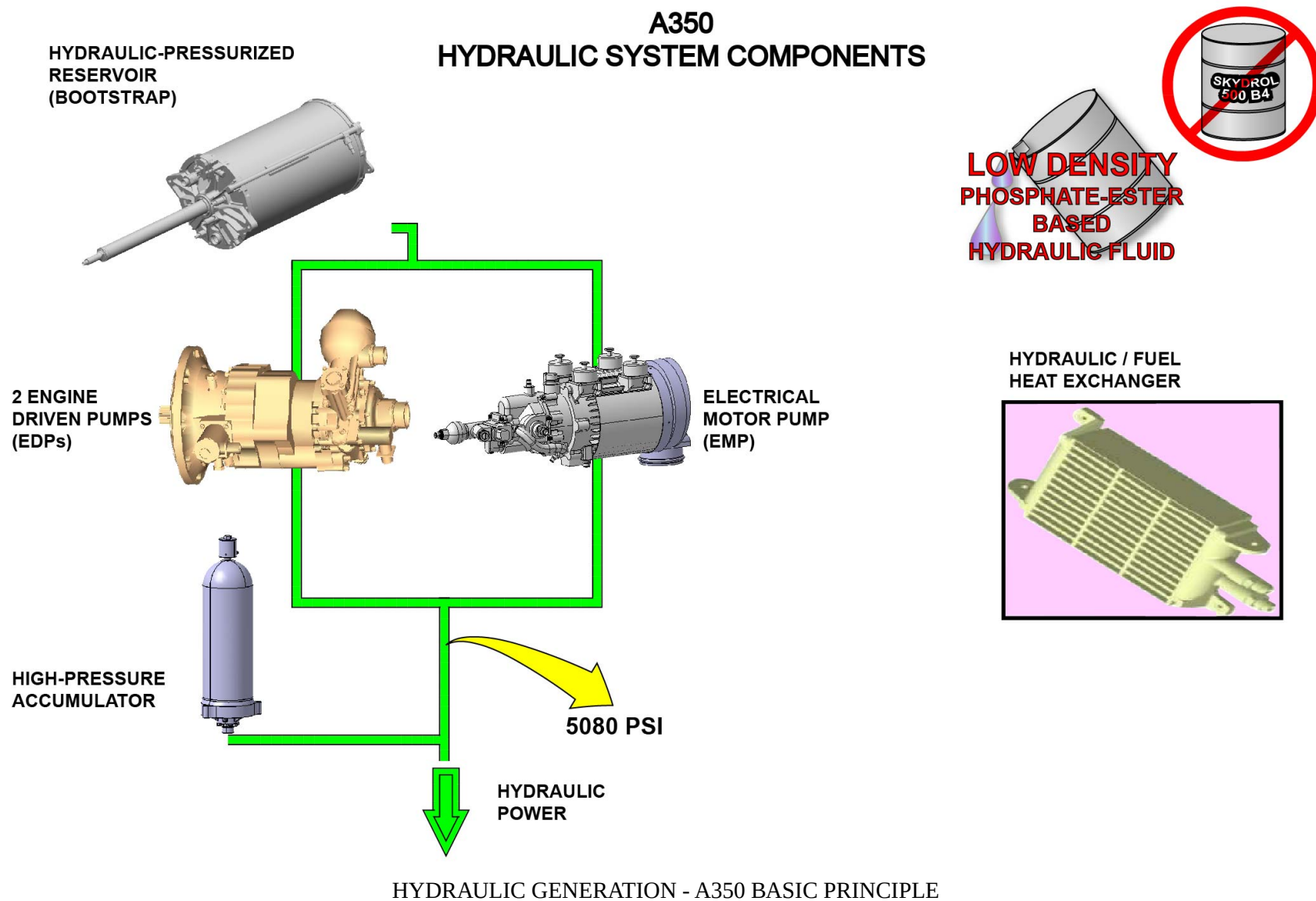
A high-pressure hydraulic system that operates at 5080 psi, and that has been used in military aircraft, is now used in large transport aircraft design like the A350. Its architecture is similar to a conventional hydraulic system and has:

- A hydraulic-pressurized reservoir (bootstrap),
- 2 engine-driven pumps, which are variable displacement pumps driven by the engine, to control the system pressure to 5080 psi,
- 1 electrical motor pump, to supply an auxiliary hydraulic power source,
- A high-pressure accumulator.

Because the natural cooling dissipation is not sufficient, heat exchangers are installed to keep the temperature of the hydraulic fluid in a satisfactory range. They use the natural low-temperature properties of the fuel and are located in the wing tanks.

To have a correct Hydraulic System performance, only Low-Density phosphate-ester based hydraulic fluids can be used in hydraulic systems with 5080-psi high-pressure lines. Skydrol LD4, Hyjet IVA+ and Hyjet V MP are the only qualified hydraulic fluids today for the A350.

It is not permitted to use SKYDROL 500B4, although it is an NSA 307110 compliant fluid.



5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

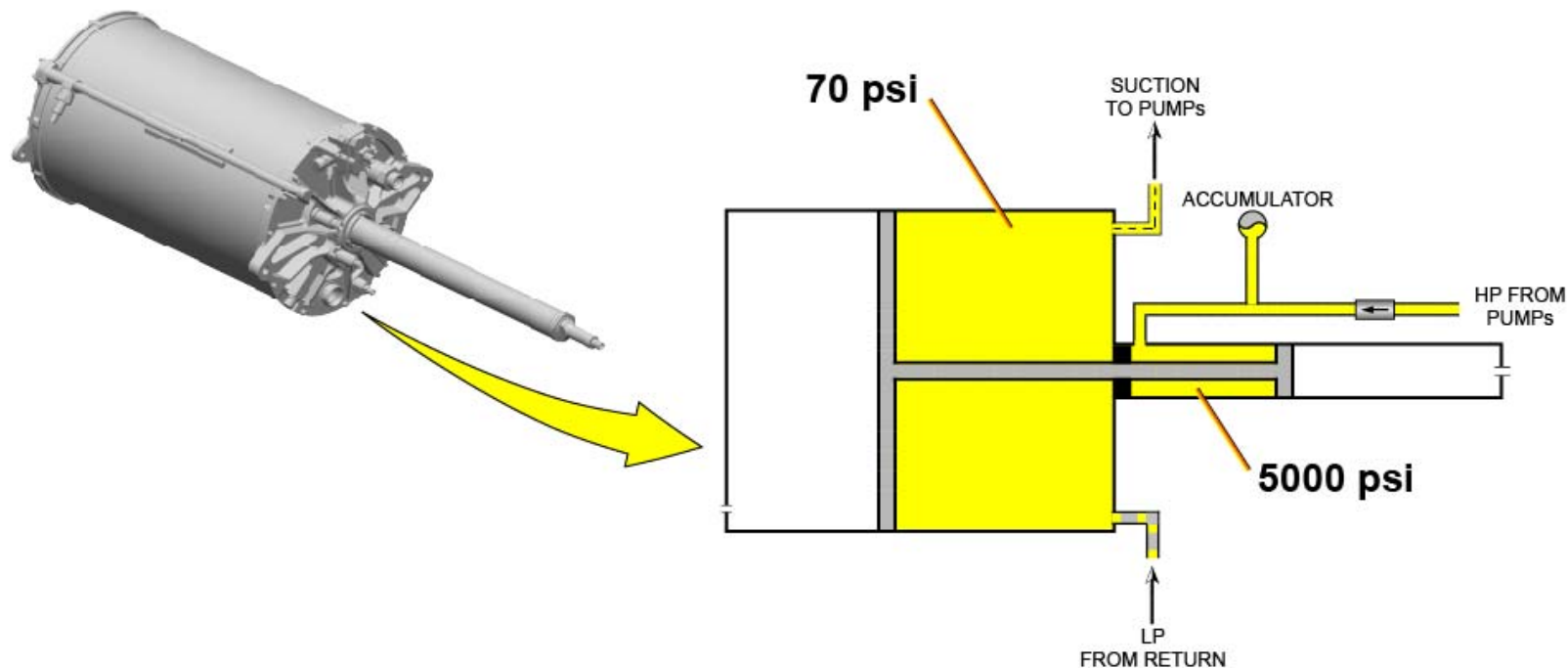
Hydraulic Generation (continued)

Bootstrap Hydraulic Reservoir

A bootstrap uses a differential area piston where high-pressure hydraulic pressure from the pump outlet is applied to the small area of the piston. This causes a low pressure on the reservoir side of the piston. An important advantage of bootstrap reservoirs is that the reservoir stays pressurized during aggressive flight maneuvers, such as negative g flight.

Some other components and hydraulic plumbing are necessary for bootstrap reservoir implementation. Also, there is a check valve in the high-pressure line. This check valve keeps the reservoir pressure after the pump shutdown and thus keeps the pump inlet pressure when the engine-driven pump does not operate. An accumulator can also be used in this circuit to help keep the pump inlet pressure. The accumulator is between the check valve and the reservoir.

BOOTSTRAP HYDRAULIC RESERVOIR (A350 ONLY)



HYDRAULIC GENERATION - BOOTSTRAP HYDRAULIC RESERVOIR

XN113211 - X04NTT0 - XM29P1NEWTECH01

5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Generation (continued)

Engine Driven Pump Declutches

The declutch, which is a part of the engine-driven pump, includes a mechanical device that has an effect on the pump shaft level.

The declutch can be used when a pump malfunction occurs.

The disengagement can be done manually from the ground, when the engine is stopped, with a ring that must be pulled out.

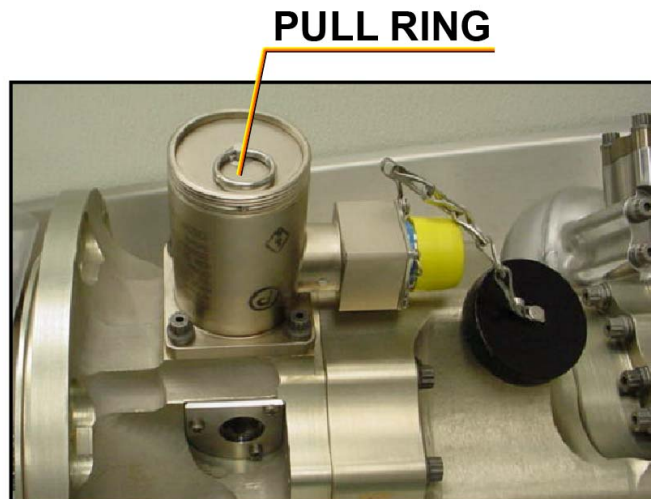
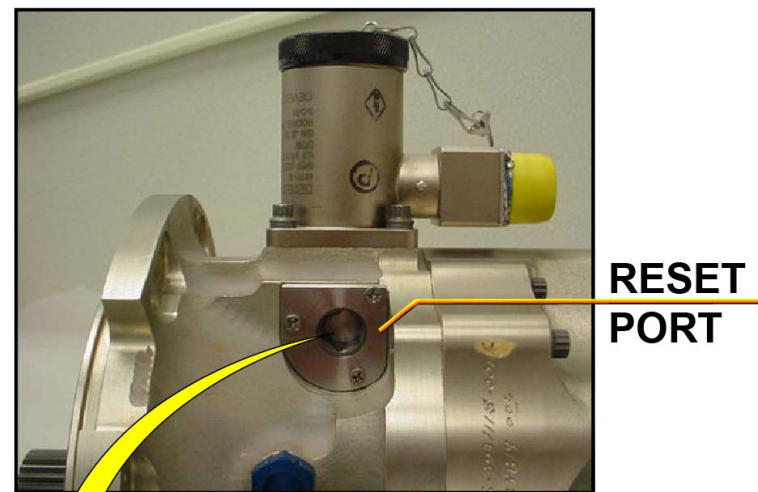
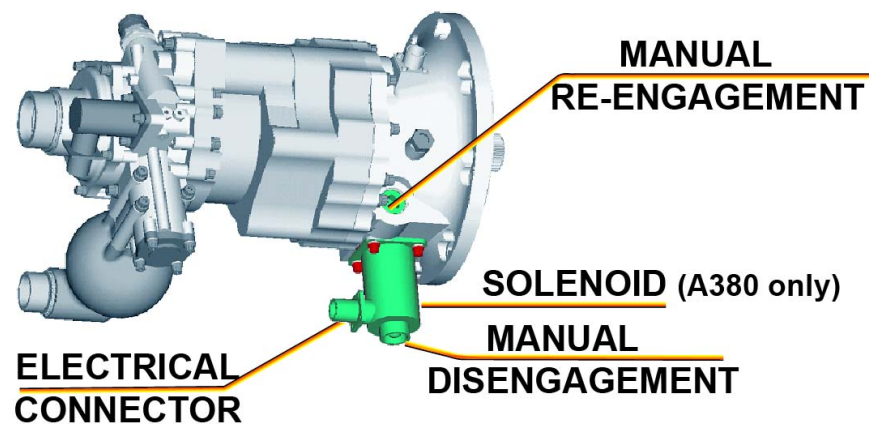
For the A380 only, the disengagement can also be done from the cockpit, when the engine operates, with a push-button switch (solenoid operated mechanism).

When the EDP is declutched, the re-engagement cannot be done from the cockpit.

After trouble identification and correction, the re-engagement of the pump to the engine accessory gear box is done manually when the engine is stopped: use a 3/8 inch square drive tool on the reset port.

On the Engine Driven Pump, there is a visual indicator which gives the position of the clutch: reset, engaged or disengaged.

The new engine driven pumps include a disengagement clutch at the drive from the engine. This lets the pilot isolate the pump if necessary in flight, or the maintenance personnel can de-activate the pump for an approved flight dispatch with an inoperative pump.



A380 EDP shown,
same principle for A350 EDP

Declutch benefit = dispatch under MMEL

HYDRAULIC GENERATION - ENGINE DRIVEN PUMP DECLUTCHES

5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Generation (continued)

Fluid and Heat Exchangers

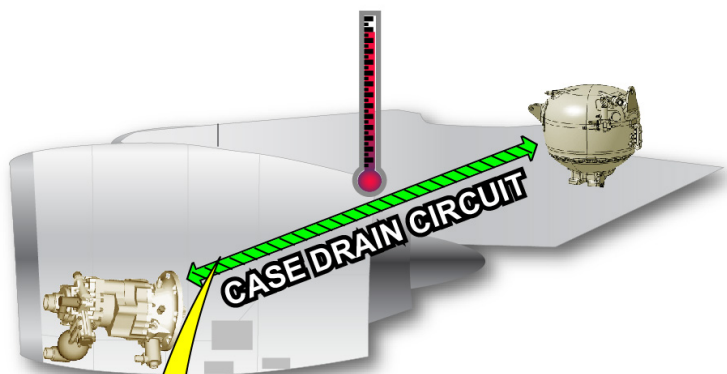
Because of the high needs of hydraulic power, a large quantity of heat goes into the hydraulic circuits. The 5080 psi pressure causes heat almost three times more than the 3000 psi pressure. Most of the heat goes into the case drain circuit from the pump internal leakage, which then increases the fluid temperature above the permitted fluid temperature.

Also, in the A380 only, the ambient air cooling effect is decreased in the case drain lines because the reservoir is installed near the pumps to prevent cavitations.

It is necessary to use heat exchangers to prevent the degradation of current hydraulic fluid, and thus a shorter lifetime of the hydraulic equipment.

There are two different types of heat exchangers:

- One type uses external air as cooling agent (A380 only),
- The other type uses the fuel contained in the aircraft tanks.



REASONS FOR USE OF HEAT EXCHANGERS (on case drain circuit)

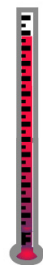
- High increase in the hydraulic fluid temperature
- The reservoir is near the pumps, which decreases the ambient-air cooling effect.
- Prevent Hydraulic Fluid Degradation and shorter lifetime of hydraulic equipment.

SA/LR

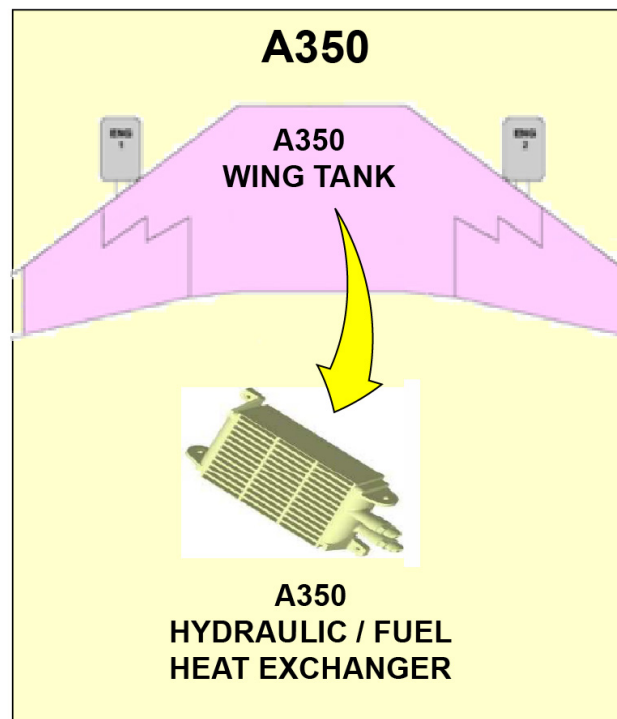
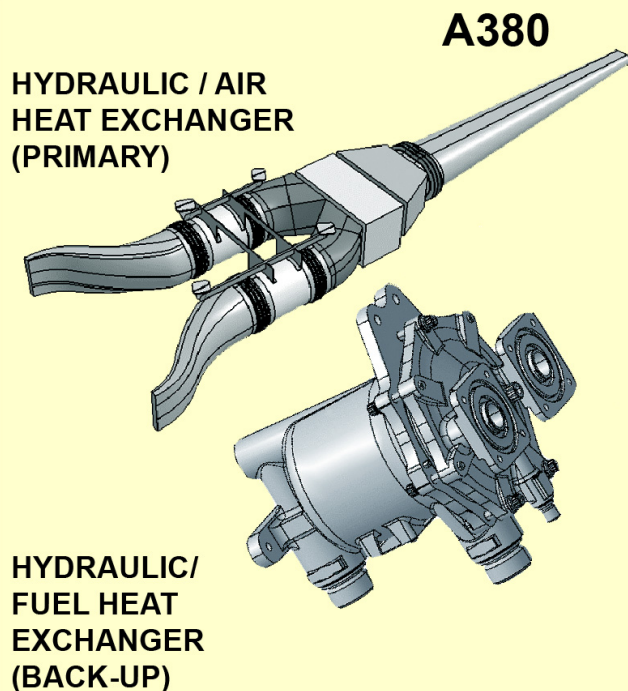
A380/A350



3000 PSI



5080 PSI

More heat
to dissipate


HYDRAULIC GENERATION - FLUID AND HEAT EXCHANGERS

5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Generation (continued)

Metal Bellow Accumulator

The high-pressure hydraulic accumulator is a metal bellow type pre-charged with Helium.

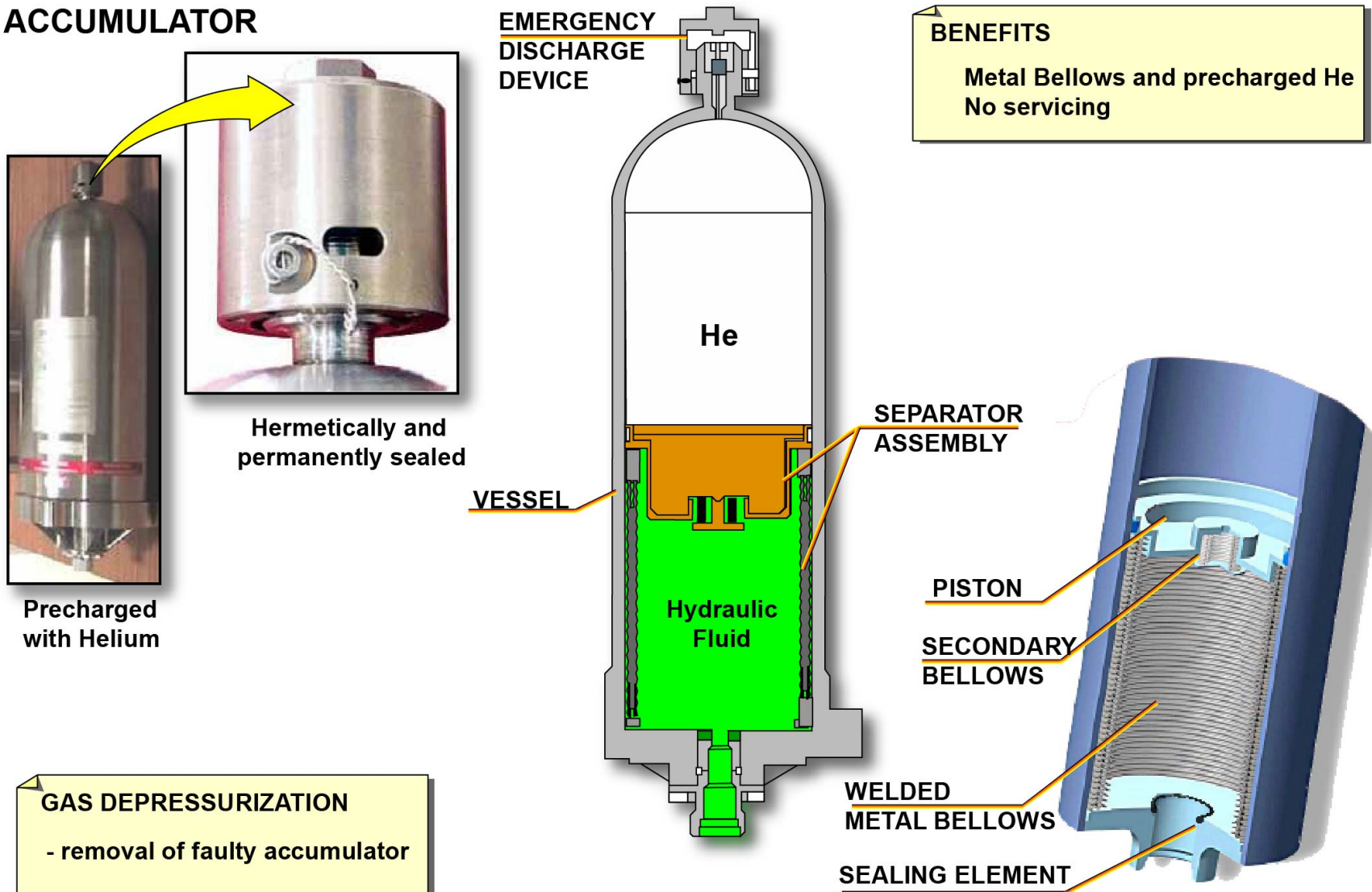
It is hermetically and permanently sealed after the gas is pre-charged.

The metal bellow accumulator has four primary components:

- A vessel, which receives the pressure load. This vessel includes a cylinder housing with a dome on the gas side, and a welded end closure on the hydraulic side.
- A separator, which includes metal bellows welded onto the end closure, and a piston. The separator assembly divides the accumulator in 2 chambers: one is charged with helium, and then sealed. The other one is connected to the hydraulic circuit. The movement of the separator in the housing is caused by the users' hydraulic demands.
- A fluid retention system, which includes secondary bellows welded onto the separator piston and a stationary sealing element located at the hydraulic port.
- An emergency discharge device, which is used for gas depressurization of the unit for transport or removal of a defective accumulator. It is safer to move an accumulator when it is depressurized.

The High-Pressure Accumulators now use a metal bellows and pre-charged helium. They have smaller dimensions and no servicing point is necessary for the gas.

ACCUMULATOR



HYDRAULIC GENERATION - METAL BELLOW ACCUMULATOR

XN13211 - X04NTT0 - XM29P1NEWTECH01

5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

Hydraulic Distribution

A typical commercial transport aircraft can contain several hundred meters of piping and thousands of fittings.

Hydraulic pipes and flexible hoses are basic components of the hydraulic power and motion control. These distribution systems supply hydraulic power through 3 types of pressurized lines on the hydraulic architecture:

- 5080-psi high-pressure lines (350-bars) made of titanium and titanium alloy,
- 1000-psi return lines (70-bars) made of titanium alloy, aluminum alloy and Corrosion RESistant Steel (CRES),
- 220-psi suction lines (15-bars) made of CRES.

Different types of hoses are used for the different lines, sizes and zones, such as:

- Classical stainless steel fiber reinforcements, and
- New Aramid fiber, known as KEVLAR® hosing reinforcements.

Kevlar hoses are used in some low-pressure lines and for all high-pressure lines. The 5080-psi KEVLAR® hoses, are already used on military aircraft.

A new set of unions has been designed and tested for the 5080-psi hydraulic lines. Although the A380 hydraulic distribution system uses fittings from previous Airbus programs in low-pressure lines after test validation, some new fittings are also used:

- Extra fine thread fittings for the new -32 suction lines,
- New fittings for the new -20 and -24 aluminum return lines, but also for -16 aluminum tubing,
- New titanium end fittings for return hoses.

As in other aircraft, sliding unions are installed in the Return, Pressure and Suction Hydraulic pipelines in the inner pylon and wing rear spar area. They are used to compensate the relative movement of the wing structure and hydraulic pipe caused by pipe thermal expansion, thermal contraction or wing deflection. As a difference from other aircraft, there are new sliding-union sizes for -32 suction lines and new -20 design

sliding-unions for 5080-psi lines, which must fulfill the 5080-psi fitting requirements.

Old MS21902 plug-in unions are replaced by new locked-ring plug-in unions, "ROSAN" type, on components and manifolds. These unions have better strength and maintainability. Maintenance operations are easier because it is not as much necessary to use a counter wrench tool on the plug-in union.

Only saddle clamps and clampblocks are used to attach a pipe to the structure with previously attached intermediate brackets. These saddle clamps and clampblocks replace the old P-Clamps types.

Different types of saddle clamps are used for the different applications:

- Saddle clamps,
- Reinforced saddle clamps, with a violet band to identify them,
- Saddle clamps for hoses, where the sliding of the line is not permitted in comparison with the other two types.

Different types of clampblocks are used in the pipe routing with a maximum 5-hole type and only two groups:

- Fixing Clampblocks,
- Floating Clampblocks, which hold pipes together between two fixed points to prevent low-frequency vibration.

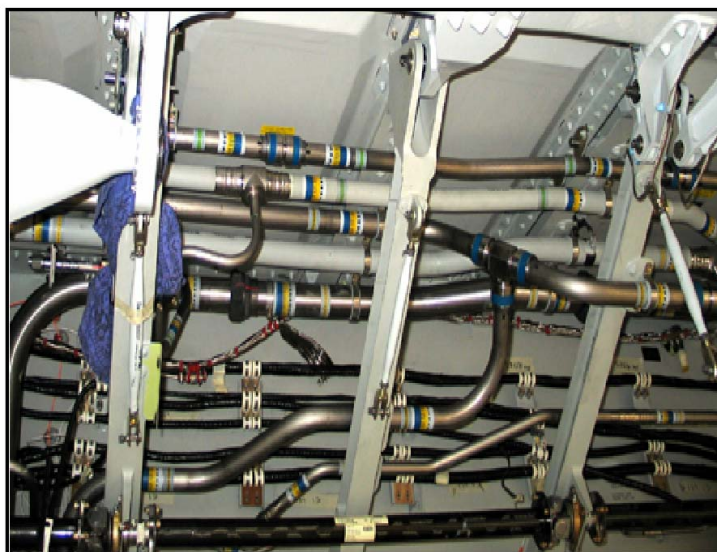
All new clampblocks have a new technology design and benefits such as:

- Silicone-Elastomer dual damper effect,
- Higher built-in tolerances for pipe installation,
- Less pipe chafing,
- Lighter and cheaper than modular clampblock.

Blue types are used in fuel tanks and brown ones out of fuel tanks because of different fire requirement properties.

HYDRAULIC DISTRIBUTION

RIGID PIPES



HOSES



**HIGH-PRESSURE
LINES**

**TITANIUM
+
TITANIUM ALLOY**

RETURN LINES

**TITANIUM ALLOY
+
ALUMINUM ALLOY
+
CRES**

SUCTION LINES

**CRES: Corrosion
REsistant Steel**

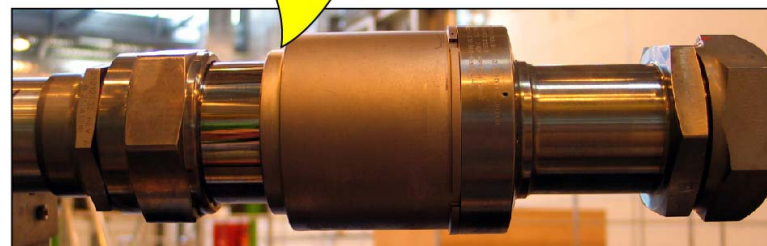
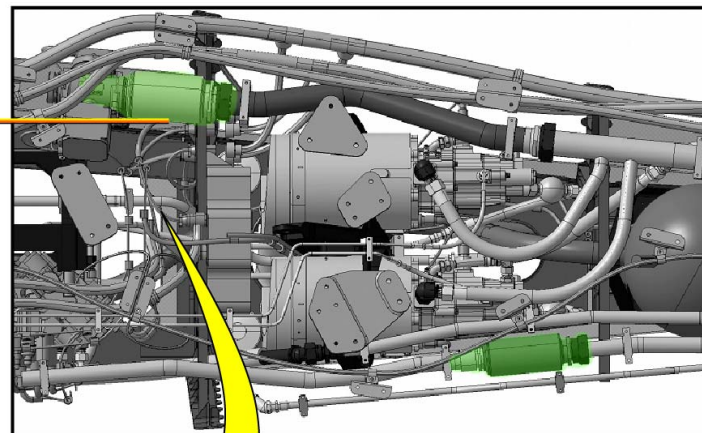
HYDRAULIC DISTRIBUTION

XN113211 - X04NTT0 - XM29P1NEWTECH01

**-20 5080-psi
SLIDING-UNION**

NEW UNIONS:

- New 5080-psi unions
- extra fine thread fittings for HP lines
- new titanium end fittings for return hoses

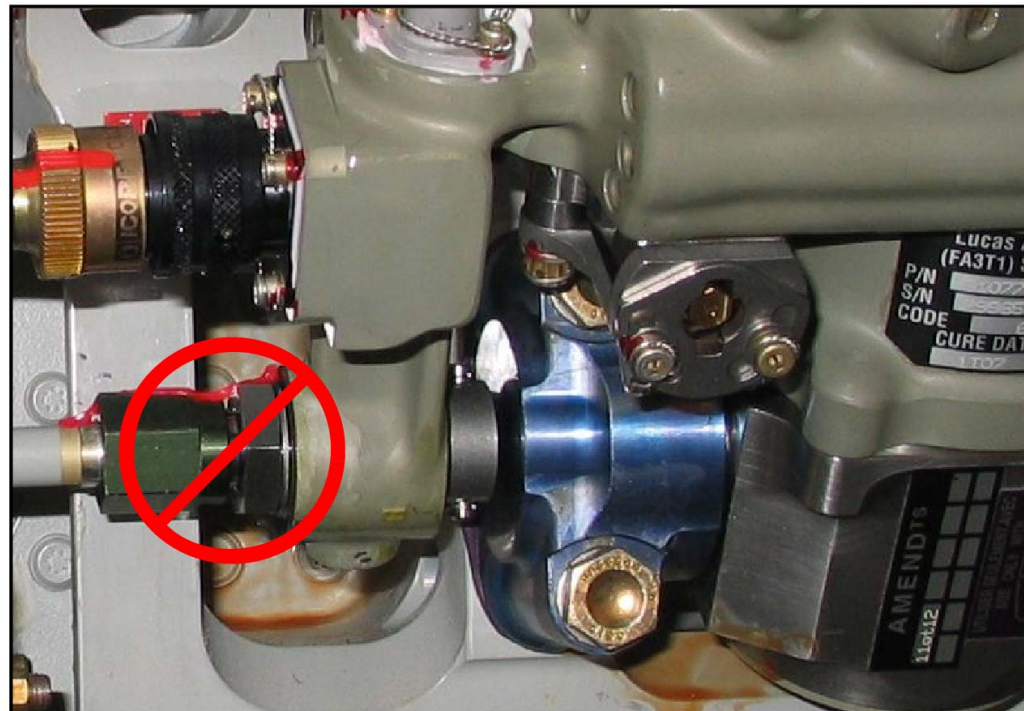
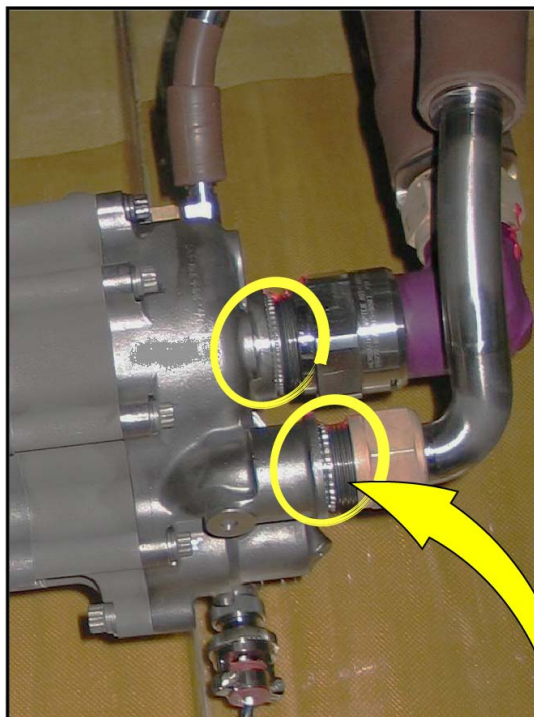


-32 SUCTION SLIDING-UNION

SLIDING-UNIONS

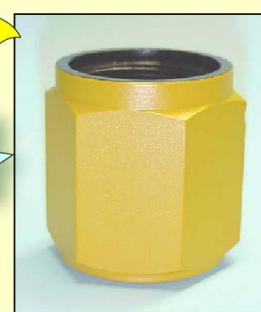
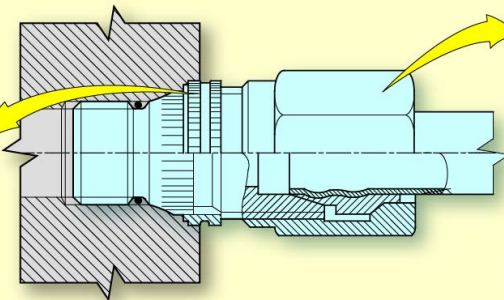
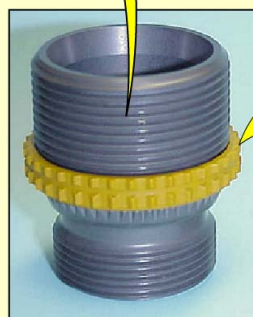
- in inner pylons and wing rear spar area
- to compensate changes in hydraulic piping length

HYDRAULIC DISTRIBUTION



LOCKED-RING PLUG-IN UNIONS

- better performance and maintainability
- no need of counter wrench tool



HYDRAULIC DISTRIBUTION

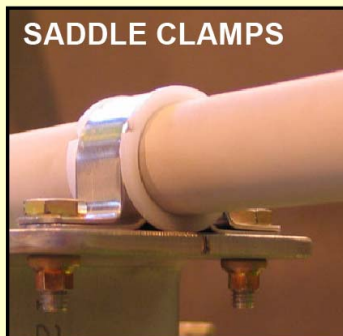
PIPE FIXATION



No P-Clamps types



SADDLE CLAMPS



CLAMPBLOCKS

maximum
5-hole type



- FIXING
CLAMPBLOCKS



- FLOATING
CLAMPBLOCKS



BENEFITS:

- Silicone-Elastomer dual damper effect
- Higher built-in tolerances
- Less pipe chafing
- Lighter and cheaper

IDENTIFICATION

- blue ones : in fuel tanks
- brown ones: out of fuel tanks

HYDRAULIC DISTRIBUTION

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5080-PSI: HYDROMECHANICAL COMPONENTS PRESENTATION

5080-Psi Pipes Permanent and Temporary Repairs

Only three types of permanent repairs are fully qualified. They use three different types of fittings, which are manufacturing standard fittings for all sizes of 5080-psi rigid pipes:

- RYNGLOK R5 fittings,
- RYNGLOK R8 fittings with extra fine threads,
- PERMASWAGE "PERMALITE" method.

Other types of fittings are used as temporary repair solutions for 5080-psi rigid pipes:

- RYNGLOK R8 fittings, currently used for repair of other Airbus aircraft, but only swaged-swaged unions,
- Stanley-Harrison H-fittings,
- Kevlar hoses.

Note: Too much bending or unusual curving will cause a shorter lifetime of Kevlar hoses. Always do a check of the minimum curvature radius (refer to the AMM 20-23-11 chapter).



5080 psi pipes Repair Solution	REPAIR TYPE
FITTING	
RYNGLOK R5	PERMANENT
RYNGLOK R8 Extra Fine Threads	PERMANENT
PERMASWAGE "PERMALITE" method	PERMANENT
RYNGLOK R8 only swaged-swaged unions	TEMPORARY
H-Fittings	TEMPORARY
KEVLAR HOSES	TEMPORARY

VIDEO: RINGLOCK REPAIR



KEVLAR HOSES

5080-PSI PIPES PERMANENT AND TEMPORARY REPAIRS

DIGITAL COMMUNICATION MEANS PRESENTATION

WIFI/WLAN

The Wireless Fidelity (WI-FI) is a wireless communication mean that lets two items of equipment exchange data without a physical connection between them.

Note: A Wireless Local Area Network (WLAN) is a LAN using a wireless communication technology such as WIFI.

With the WIFI communication standard, data exchange is possible from 6 Mbit/s to 600 Mbit/s. This variation is related to the WIFI standard used and the ground communication infrastructures available.

Usually, the WIFI communication means is used at the gate to send/receive information with airline facilities. Ex on A350: Flight/Cabin Ops data, Maint data (PFR, conf files), Field Loadable Software.

The maximum communication range of the WIFI is approximately 50 m inside and 300 m in open field environment.

The WI-FI relay antenna of the airport will relay the data through wired communication to the airline facilities.

Wireless Fidelity (WI-FI) :

- Wireless communication mean to exchange data
- Data Flow: 6 Mbit/s to 600 Mbit/s
- Maximum Communication Range: 50 m inside / 300 m in open field



**SECURED
COMMUNICATIONS**

Ex on A350: Flight/Cabin Ops data,
Maint data (PFR, conf files), Field
Loadable Software



AIRCRAFT ON GROUND



**AIRPORT WIFI
RELAY ANTENNAE**



AIRLINE FACILITIES

WIFI/WLAN

DIGITAL COMMUNICATION MEANS PRESENTATION

Cellular Communication

The Cellular communication means is a wireless means that lets two items of equipment exchange data without a physical connection between them. This communication means uses a geographical network divided in cells. There is only one antenna per cell.

The maximum communication range is 35 km between the aircraft equipment and a relay antenna. The standard used on A350 is the 3G (UMTS).

With the Cellular communication means, data exchange is up to 2 Mbit/s maximum.

Usually, the Cellular communication means is used at the gate to send/receive information with airline facilities. Ex on A350: Flight/Cabin Ops data, Maint data (PFR, conf files).

Cellular Communication (Mobile Phone Network / 3G)

- Wireless communication means for data communication
- Geographical network divided in cells --> one antenna per cell
- Data Flow: Up to 2 Mbit/s
- Maximum Communication Range: 35 Km (geographical cell radius)



**SECURED
COMMUNICATIONS**

Ex on A350: Flight/Cabin Ops data,
Maint data (PFR, conf files).



AIRCRAFT ON GROUND



CELLULAR ANTENNAE



AIRLINE FACILITIES

CELLULAR COMMUNICATION

DIGITAL COMMUNICATION MEANS PRESENTATION

Leaky Line Antenna

The Leaky Line antenna supplies the RF signals in all the cabin in the spectrum from 400 MHz to 6 GHz (e.g. WLAN, GSM, instead of several conventional antennae for each RF system and frequency range).

With the leaky line antenna, there is a high availability of the wireless communication links for the wireless devices in all the cabin.

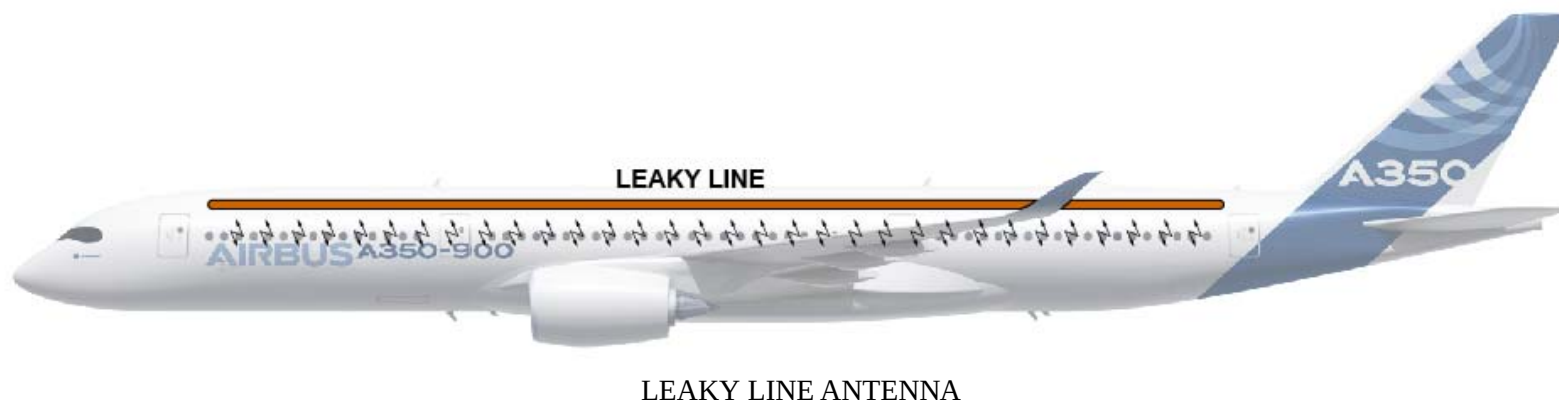
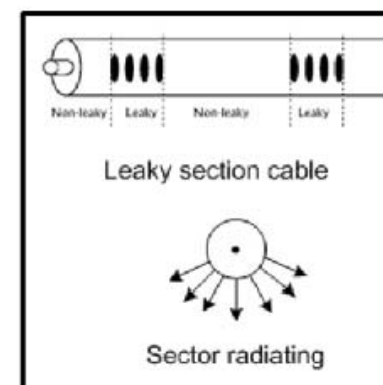
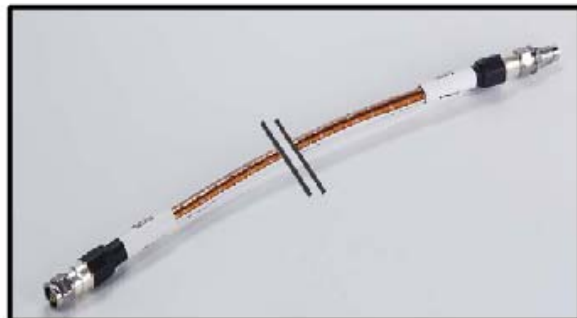
The leaky line antenna is made of a coaxial cable with leaky sections spread all along the lower part of the length, which gives wide lower sectors radiating.

Leaky Line Antenna

- Radiates and receives WI-FI and Cellular radio frequency signals in all the cabin
- Coaxial cable with leaky sections spread along the lower part of the length



**SECURED
COMMUNICATIONS**



DIGITAL COMMUNICATION MEANS PRESENTATION

IP Communication

The IP (Internet Protocol) communication protocol is a new standard of communication that uses the Internet protocol: a message sent in IP format can be transmitted through the public Internet network.

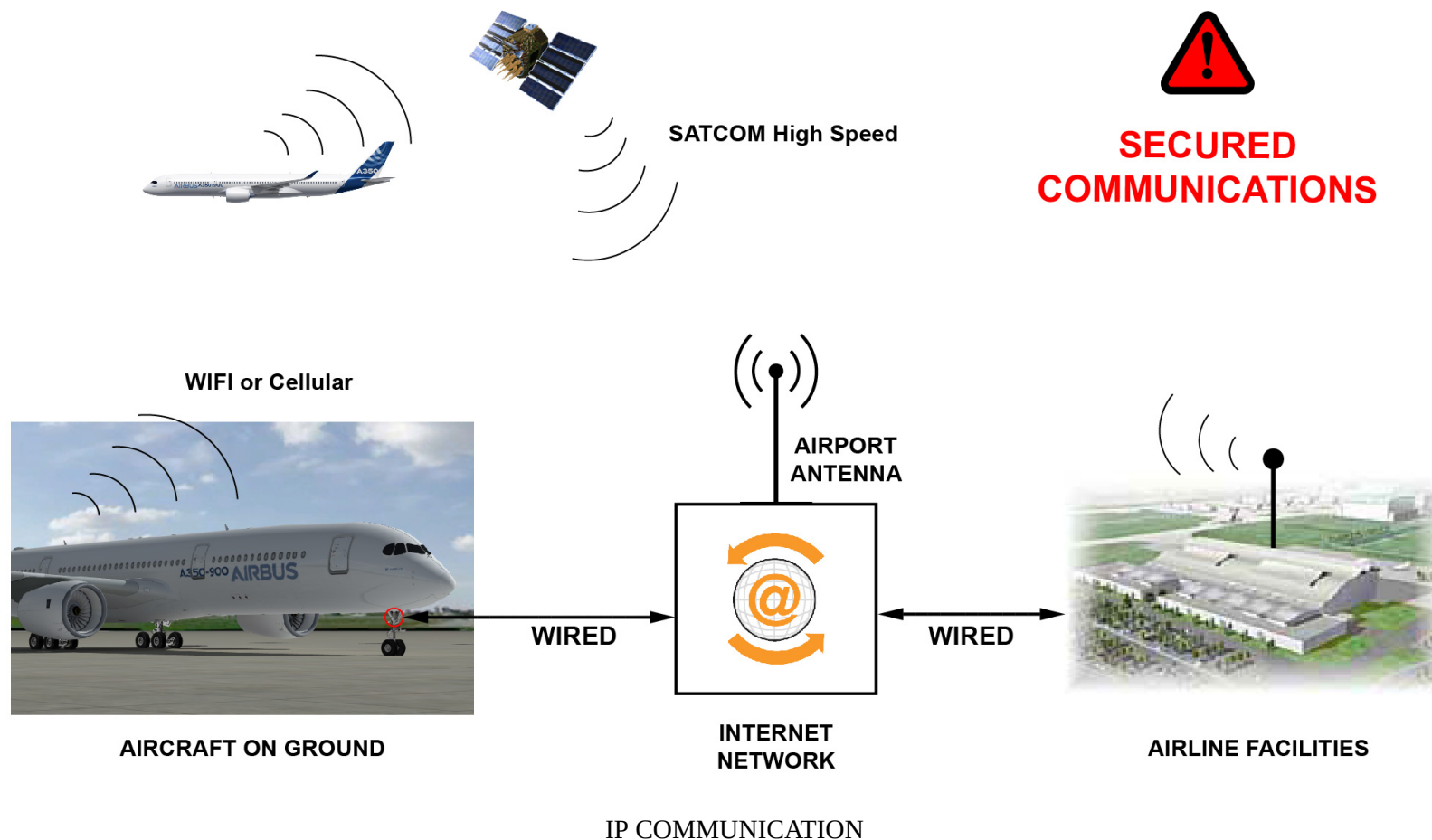
Thus, messages sent in IP Communication standard will have the advantage to go quicker and will be less expensive than ACARS or SITA conventional communications.

IP Communications can be used in flight or on the ground:

- In flight: IP communications will be used for high-speed satellite communications (e.g.: Internet access, Live TV, etc.)
- On the ground: IP communications will be used for Wireless (WIFI, Cellular) or wired gate communications (e.g.: Airline communication).

Internet Protocol (IP) Communication (A350 only):

- Data communication through the public INTERNET NETWORK,
- for Pax, IFE and AOC communications.



AIR TRAFFIC MANAGEMENT AND SURVEILLANCE PRESENTATION

ELEMENTARY SURVEILLANCE (ELS)

The Elementary Surveillance (ELS) is used for a basic communication between the Secondary Surveillance Radar (SSR) of the Air Traffic Control (ATC) ground station and the on-board ATC Transponder.

There are 2 frequencies: 1030 Mhz for SSR radar interrogation and 1090 Mhz for Transponder modulated by pulses for 3 modes:

- Mode A : identification,
- Mode C : Coded Barometric Altitude referenced to Standard Altitude (1013 Hpa) giving Flight Level,
- Mode S : Data Link - Used for TCAS, selective interrogation, and elementary surveillance.

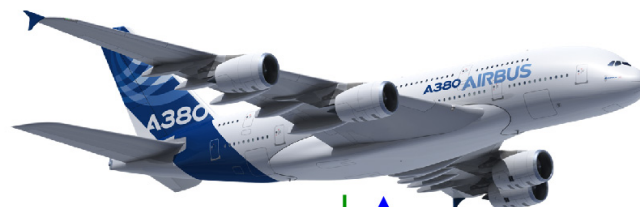
ELEMENTARY SURVEILLANCE WITH SSR MODES A, C, S

REMINDER ON TRANSPONDER BASICS :

- **MODE A** : SQAWK CODE - 0000 TO 7777 (4096 codes)
- **MODE C** : BAROMETRIC ALTITUDE REPORTING (flight level)
- **MODE S** : SELECTIVE INTERROGATION - 24-BIT ADDRESS

ELEMENTARY SURVEILLANCE (ELS) :

- 24-BIT ADDRESS
- FLIGHT NUMBER
- AIRCRAFT ALTITUDE (flight level)
- RA REPORT
- TRANSPONDEUR CAPABILITY REPORT
- ALTITUDE/GROUND REPORTING
- FLIGHT STATUS
- SURVEILLANCE IDENTIFIER (SI)



REPLY
1090 MHz

INTERROGATION
1030 MHz



SECONDARY SURVEILLANCE RADAR

ELEMENTARY SURVEILLANCE (ELS)

AIR TRAFFIC MANAGEMENT AND SURVEILLANCE PRESENTATION

ENHANCED SURVEILLANCE (EHS)

Enhanced surveillance parameters are transmitted to ATC in the same way as ELS. The mode S interrogation will request the enhanced surveillance parameters and the transponder will transmit them if the option is applied.

The specific parameters related to the enhanced surveillance are:

- selected altitude,
- barometric pressure setting,
- roll angle,
- track angle rate,
- true track angle,
- ground speed,
- true air speed,
- magnetic heading,
- indicated airspeed,
- mach,
- barometric altitude rate,
- inertial vertical velocity.

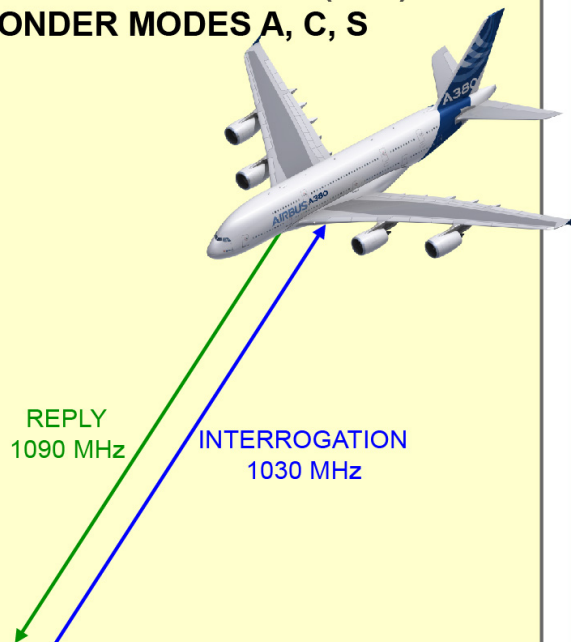
Extended squitters are transmissions from the transponder not requested from ATC (unsolicited).

The specific parameters related to the extended squitters are:

- altitude,
- longitude,
- latitude,
- movement,
- ground track,
- flight number,
- E/W velocity,
- N/S velocity,
- vertical rate.

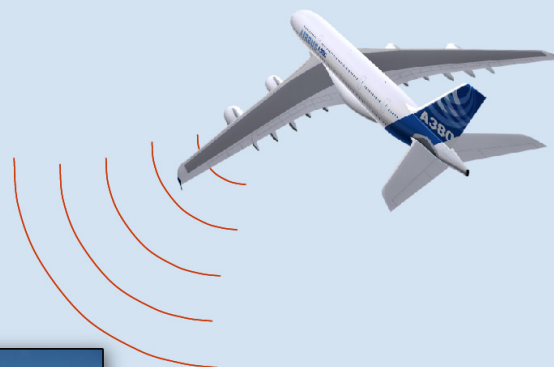
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ELEMENTARY SURVEILLANCE (ELS) TRANSPONDER MODES A, C, S



SECONDARY SURVEILLANCE RADAR

ENHANCED SURVEILLANCE (EHS) WITH ADS-B MODE S TRANSPONDER (NO ROUTING FROM ATSU)



ADS-B :

- Automatic** : No action required from flight crew
- Dependant** : Aircraft position provided by aircraft
- Surveillance**
- Broadcast** : Transmission of data without solicitation

ADS-B sends aircraft parameters :

- when the aircraft is in flight
- when the aircraft is on ground

ENHANCED SURVEILLANCE (EHS)

LANDING SYSTEMS PRESENTATION

Instrument Landing System (ILS)

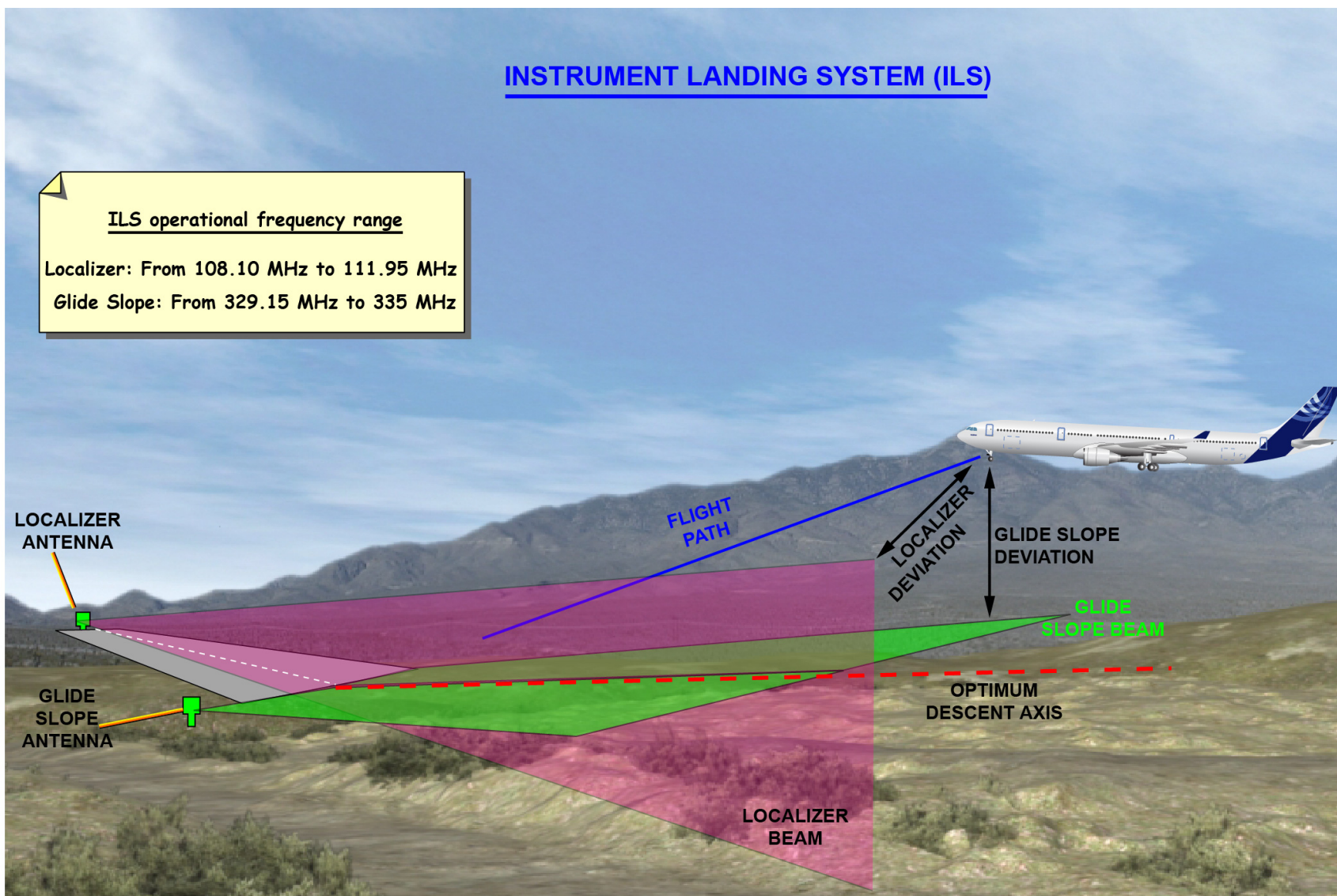
The ILS function is used for precision approach and landing by giving to the crew and A/C systems LOC (Localizer) and G/S (Glide Slope) deviation signals. The ILS has ground stations sending information to the crew and aircraft systems to guide the A/C along a predetermined flight path for the landing phase. The airborne ILS receiver measures and displays angular deviations with respect to this predetermined flight path and decodes the morse audio signal, which identifies the ground station. A descent axis is determined by the intersection of a localizer beam (LOC) and a Glide Slope beam (G/S) generated by the ground stations. Precision approach...

INSTRUMENT LANDING SYSTEM (ILS)

ILS operational frequency range

Localizer: From 108.10 MHz to 111.95 MHz

Glide Slope: From 329.15 MHz to 335 MHz



INSTRUMENT LANDING SYSTEM (ILS)

XN113211 - X04NTT0 - XM34P1NEWTECH01

LANDING SYSTEMS PRESENTATION

FMS Landing System (FLS)

The FLS function is used for non-precision approaches.

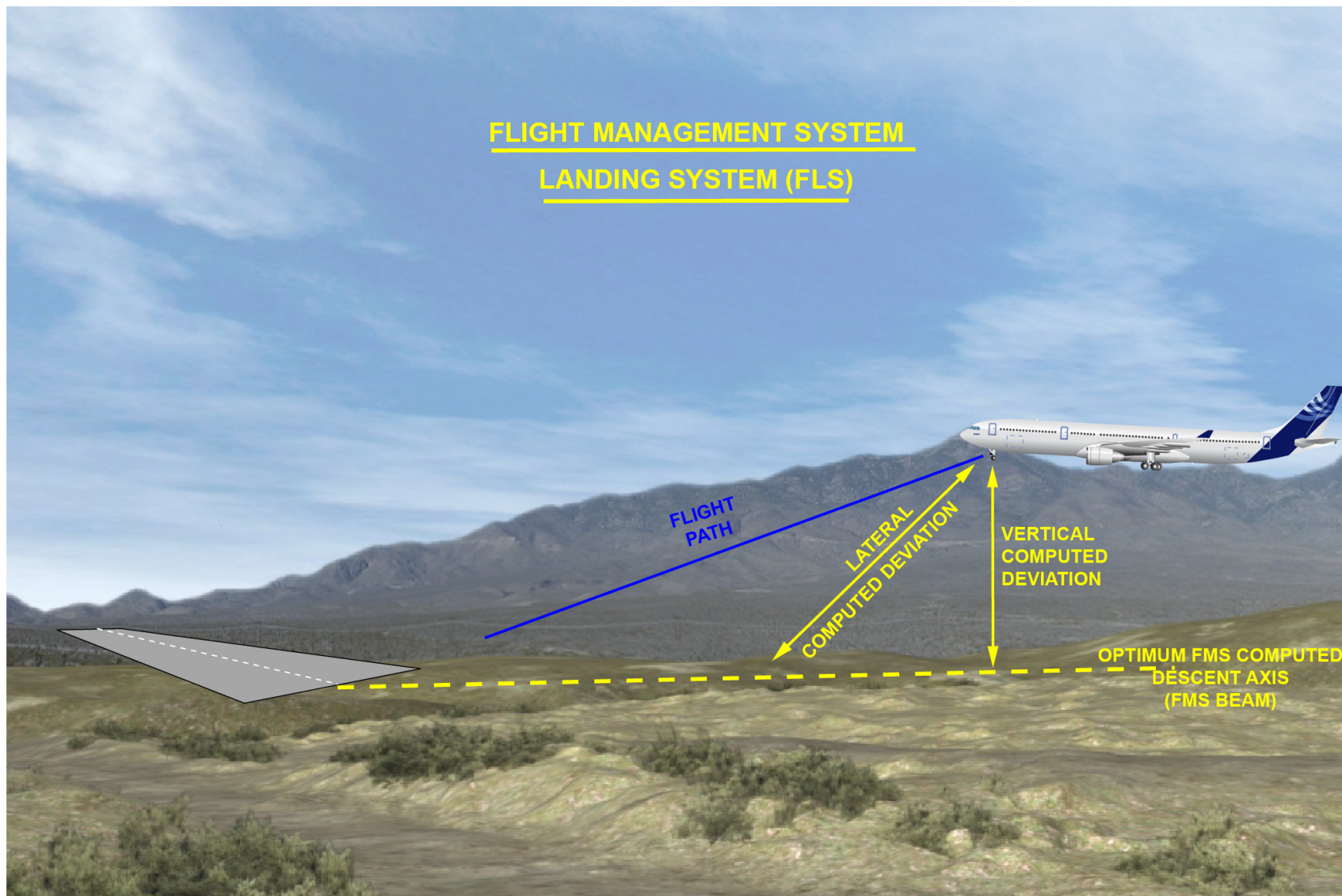
The FLS principle is to acquire the FLS beam data, given by the FMS.

The FMS calculates this information with:

- the FMS data, extracted from the FMS database,
- the A/C position.

The aircraft computes and provides the lateral and vertical guidance: pseudo-LOC (F-LOC) and pseudo-Glide/Slope (F-G/S) deviations.

The FLS function is autonomous and does not require any additional information.



FMS LANDING SYSTEM (FLS)

XN113211 - X04NTT0 - XM34P1NEWTECH01

LANDING SYSTEMS PRESENTATION

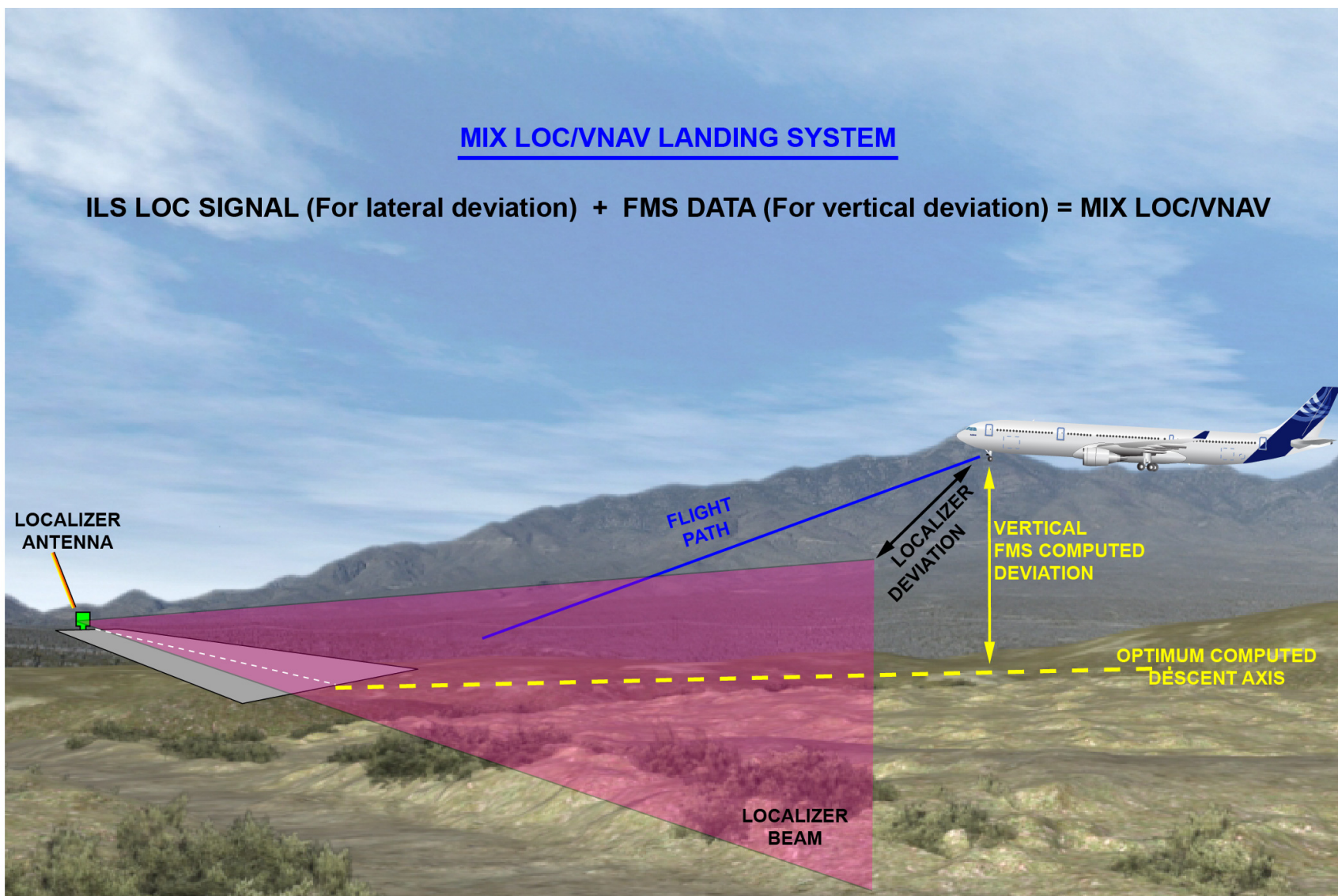
Mix LOC / VNAV Landing System

The Mix LOC/VNAV function is used for non-precision approaches. In this mode, the combined ILS and FLS functions give to the crew:

- the LOC deviation transmitted by the ground station, same as the ILS function,
- the pseudo G/S deviations in accordance with the FMS data, same as the FLS function.

MIX LOC/VNAV LANDING SYSTEM

ILS LOC SIGNAL (For lateral deviation) + FMS DATA (For vertical deviation) = MIX LOC/VNAV



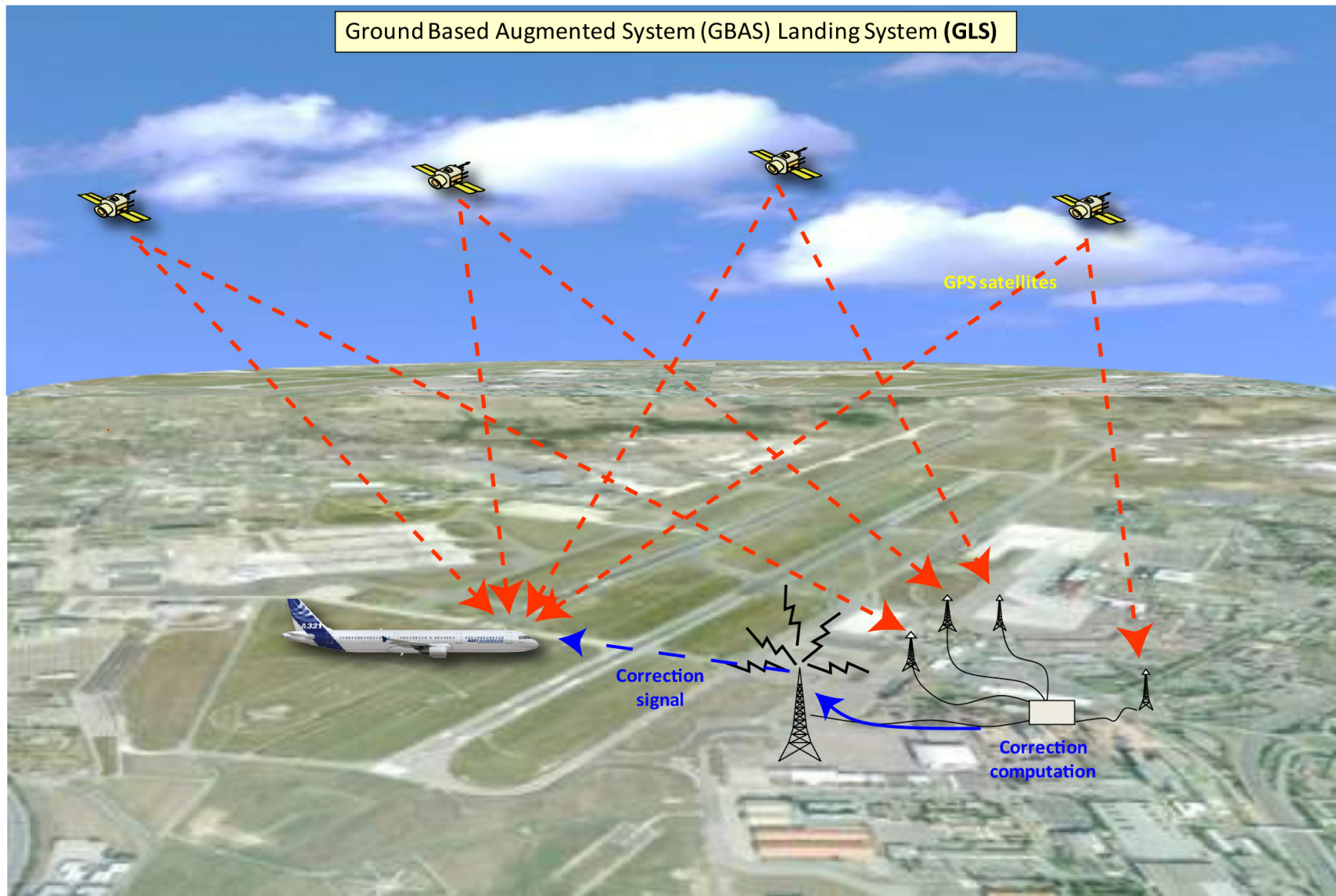
MIX LOC / VNAV LANDING SYSTEM

XN113211 - X04NTT0 - XM34P1NEWTECH01

LANDING SYSTEMS PRESENTATION

GBAS Landing System (GBAS)

This system is composed of a GLS ground station and of an airborne part in the aircraft.



GBAS LANDING SYSTEM (GBAS)

XN113211 - X04NTT0 - XM34P1NEWTECH01

LANDING SYSTEMS PRESENTATION

SBAS Landing System (SBAS)

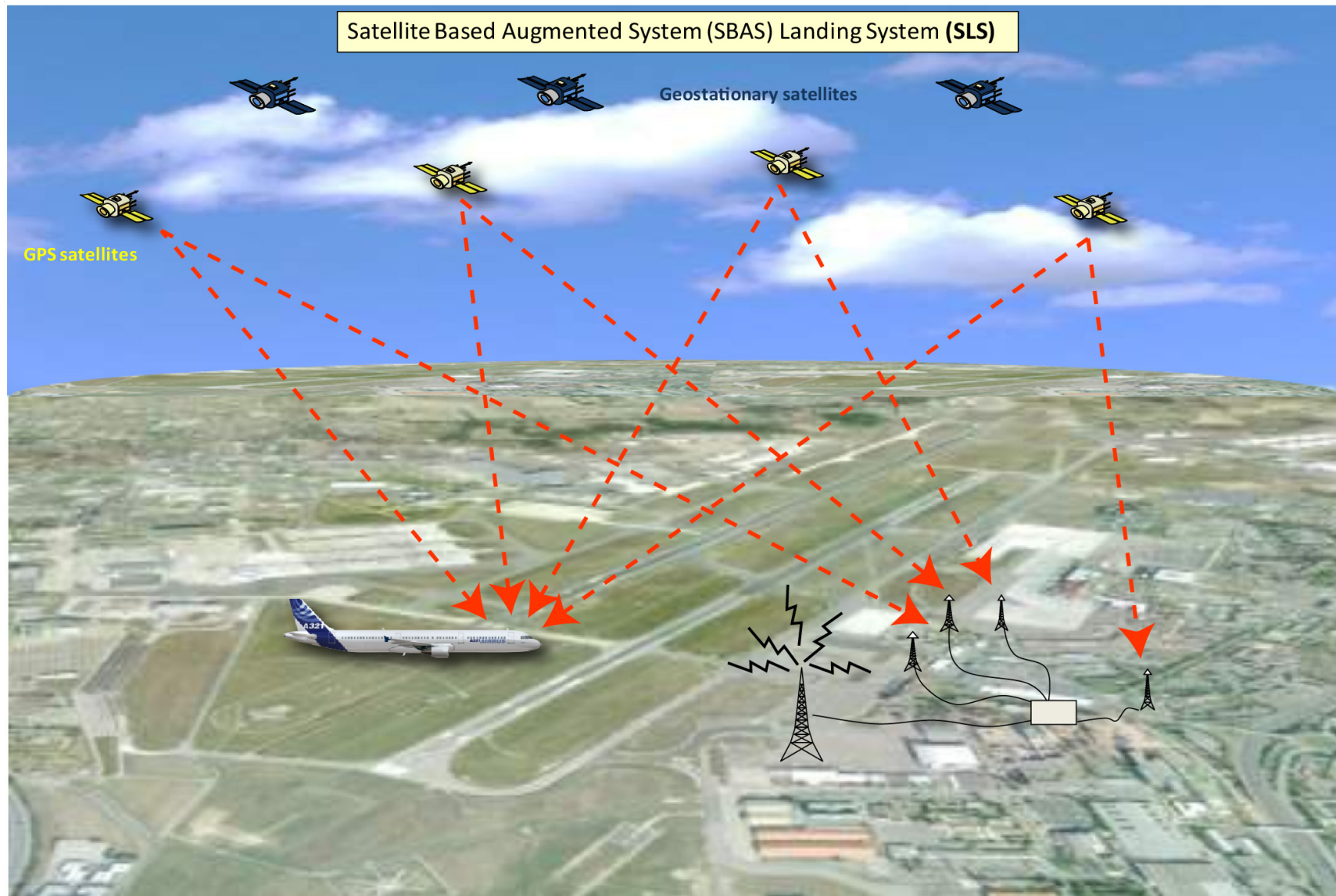
The satellite landing-system function is used for final approaches without the need of landing system ground infrastructure.

The GNSS aircraft antennas receive signals from the SBAS geostationary satellite and from the GPS satellites. The SBAS geostationary satellites send to the A/C the GPS error (range correction). The use of SBAS geostationary satellites signals in addition to the GPS satellite signals allows the aircraft to compensate the GPS error and then to compute a more accurate A/C position. This will improve the accuracy of the definitive A/C position processed by the ADIRS.

The SLS also acquires the final approach beam (that corresponds to the lateral and vertical flight path of the final approach) data from the FMS navigation database.

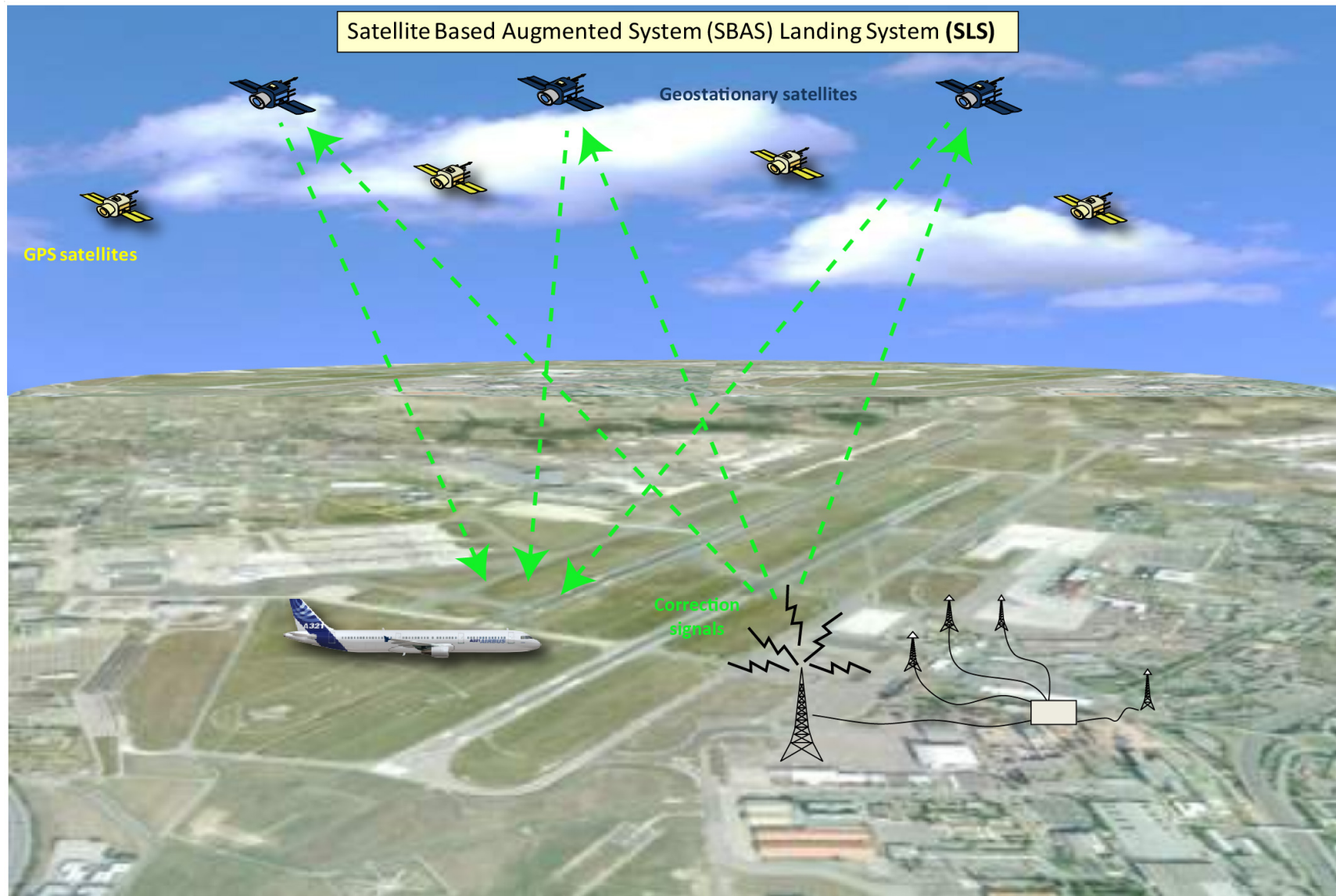
The SLS function operates independently. No other information is necessary from the ground. Thus, in this mode, it is not necessary to tune the MMRs.

Then, by using, the landing Selected Mode and the final approach beam from the FMS with the A/C position from the ADIRS, the aircraft can compute the lateral and vertical deviation signals (pseudo-LOC (F-LOC) and pseudo-G/S (F-G/S) deviations) of the final approach.



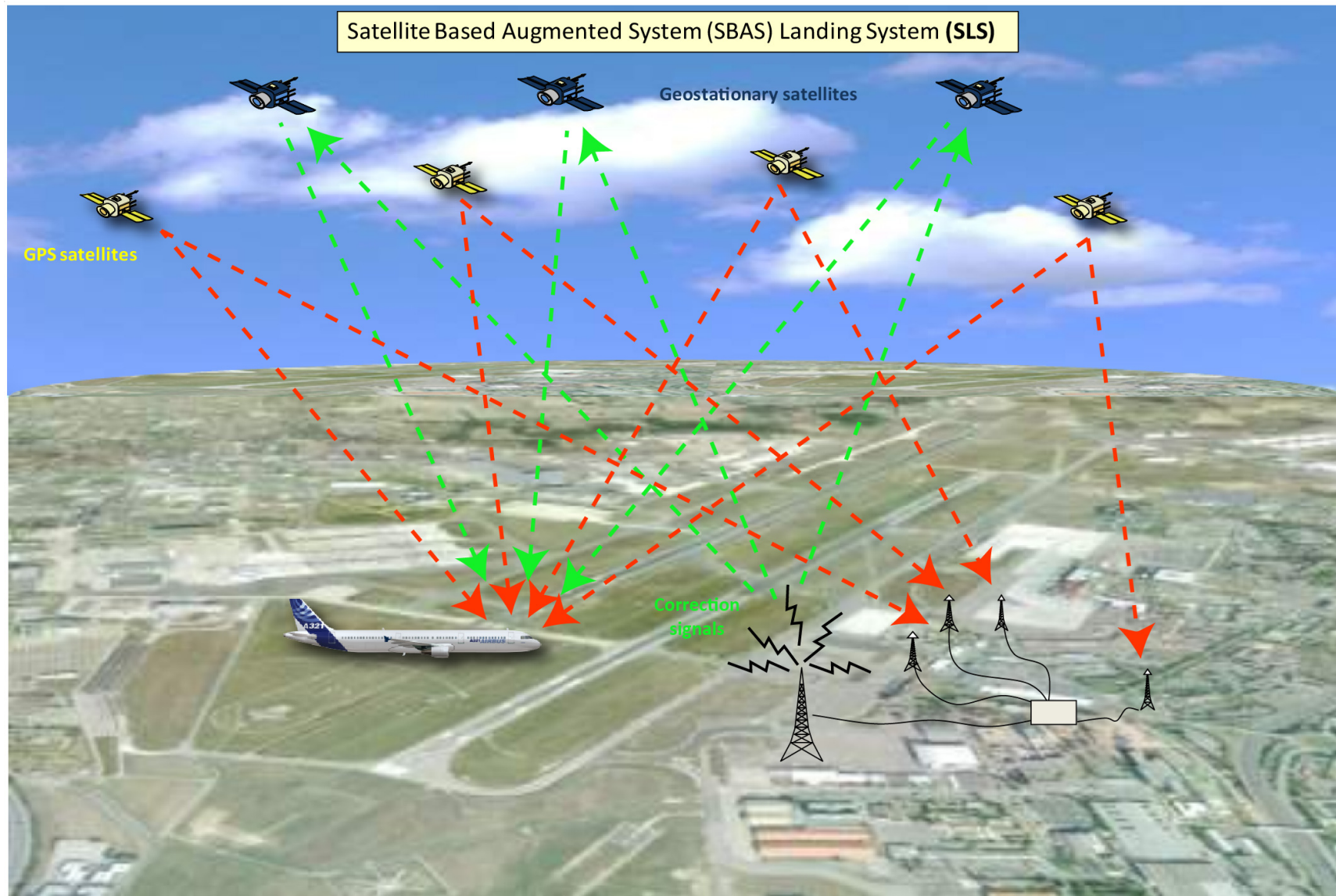
SBAS LANDING SYSTEM (SBAS)

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SBAS LANDING SYSTEM (SBAS)

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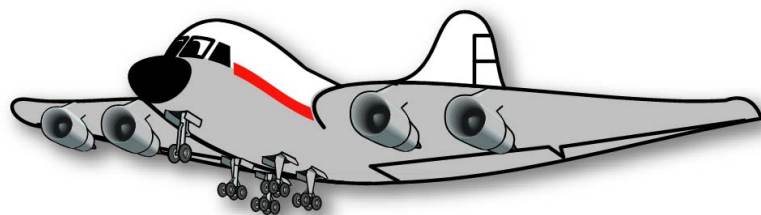
SBAS LANDING SYSTEM (SBAS)

XN113211 - X04NTT0 - XM34P1NEWTECH01

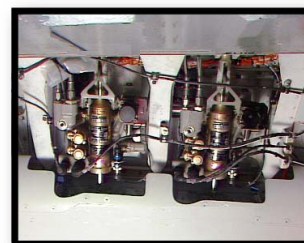
ELECTRO-HYDRAULIC SYSTEM PRESENTATION

Introduction

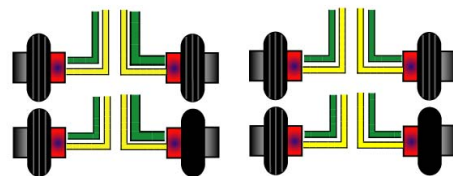
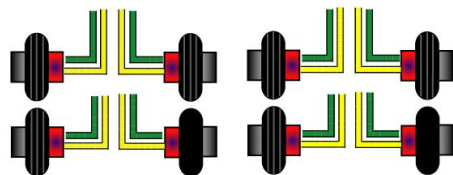
In recent times, most large aircraft used multiple hydraulic systems to have a safe and efficient operation of the landing gear systems and to move the flight control surfaces. In a conventional hydraulic architecture on large commercial airplanes, there is a minimum of three hydraulic systems that supply primary power to operate the flight control surfaces, when two are necessary to operate the brakes. But with this architecture, it was necessary to have a complex hydraulic design to get alternate hydraulic supplies and safe circuit segregation.



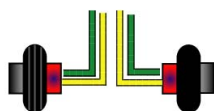
FLIGHT CONTROL SURFACES



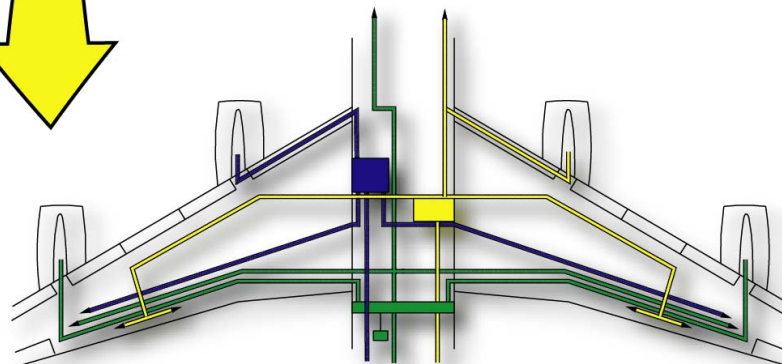
LANDING GEARS



MULTIPLE HYDRAULIC SYSTEMS



Complex Hydraulic Design



INTRODUCTION

ELECTRO-HYDRAULIC SYSTEM PRESENTATION

Definition And Application

With the new hydraulic architecture, the hydraulic power is generated by two fully independent hydraulic systems. As a backup, a local electro-hydraulic generation system is energized by electrical sources from the electrical network. Thus, new types of flight control actuators, that use electro-hydraulic technology, have been developed: the Electro Hydrostatic Actuators (EHAs) and the Electrical Back-up Hydraulic Actuators (EBHAs). Only on the A380, there are also new Local Electro Hydraulic Generation Systems (LEHGS) that operate the braking and steering systems.

With the new electro-hydraulic architecture, the third hydraulic system is no longer necessary, and the hydraulic power is generated near the components. Thus, less piping is used, which decreases the risks of fire and corrosion. Also, the routing of electrical supply cables is easier than hydraulic pipe routing (the risk of leaks can prevent installation of hydraulic pipes in or near cabin areas).

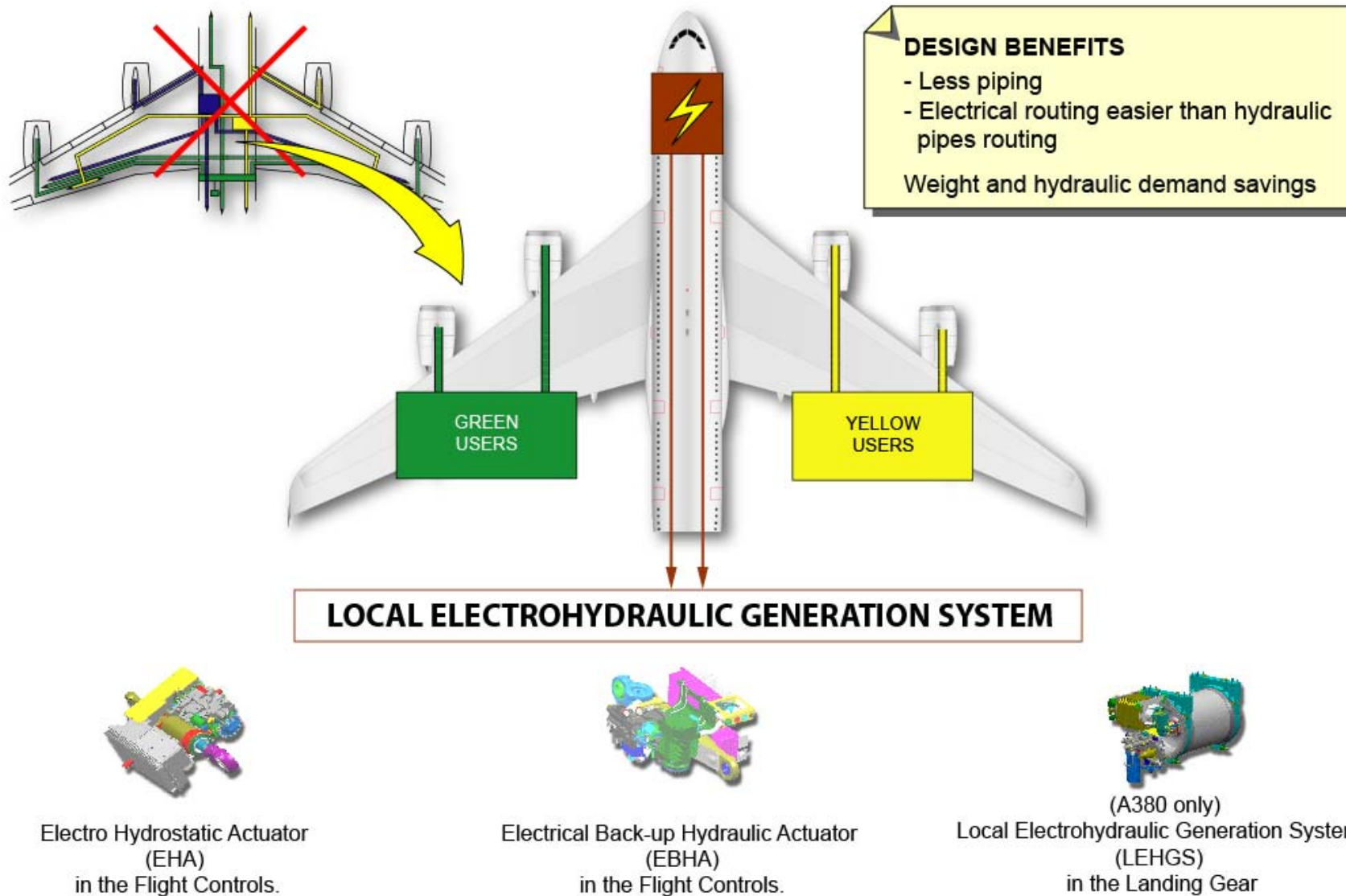
Thus, the EHA/EBHA and LEHGS help to increase the safety.

With this new electro-hydraulic architecture, there are also important weight and hydraulic demand savings in the aircraft design and an increased aircraft reliability.

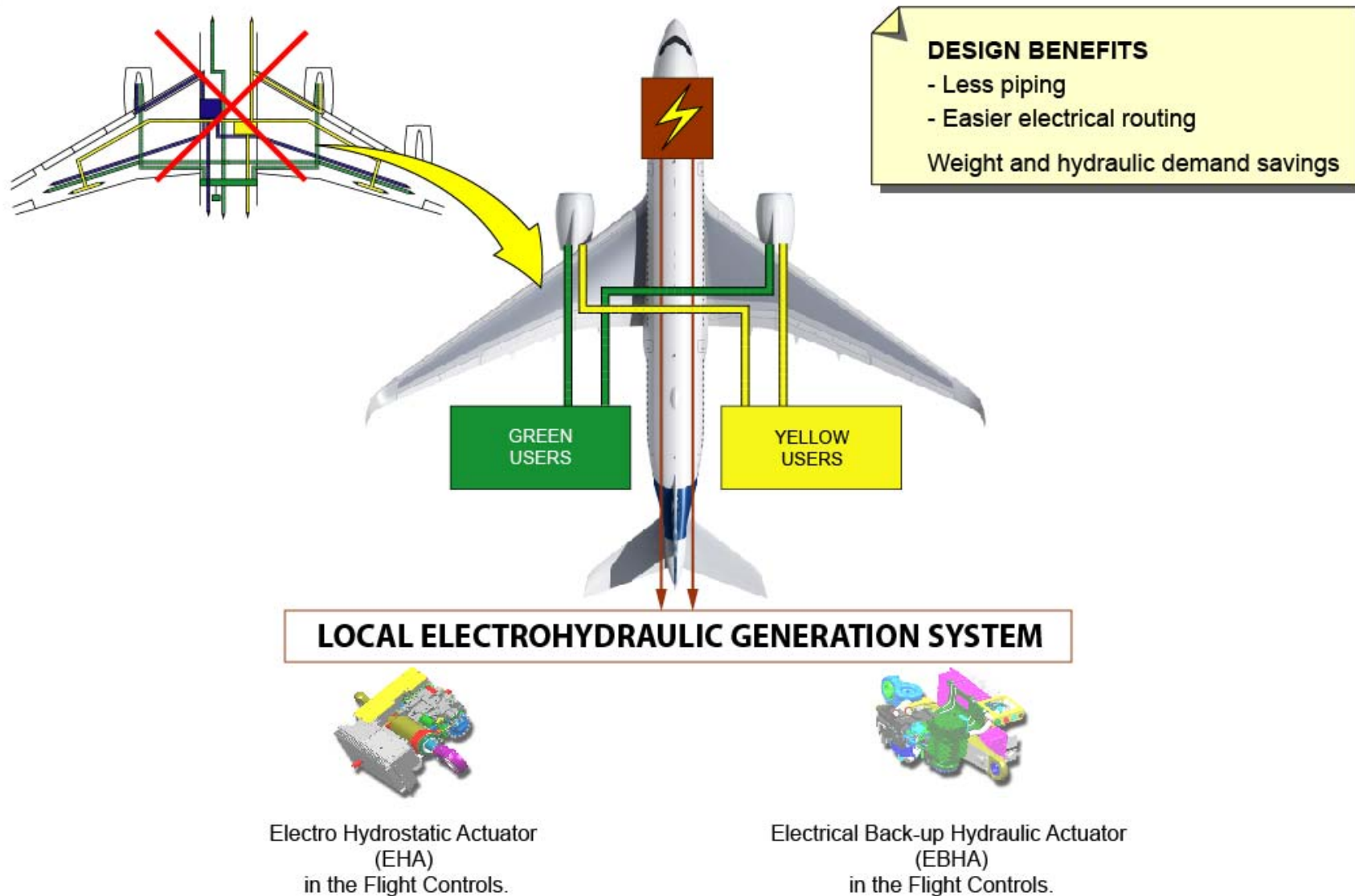
Also, with this new, less complex hydraulic system, less . maintenance activities will be necessary.

To operate the Primary Flight Controls, the electro-hydraulic actuation technology uses an electrical input to generate hydraulic pressure in the actuator using self-contained hydraulic reservoirs. They have been developed to be a redundancy to conventional servocontrols.

LEHGS are self-contained hydraulic power packs, energized from the aircraft electrical systems, and installed as a backup near the braking and steering systems. To do this, a safe and reliable back-up source of hydraulic power is available, a separate LEHGS unit is installed on the body landing gear brakes, the wing landing gear brakes, and the nose wheel steering system.



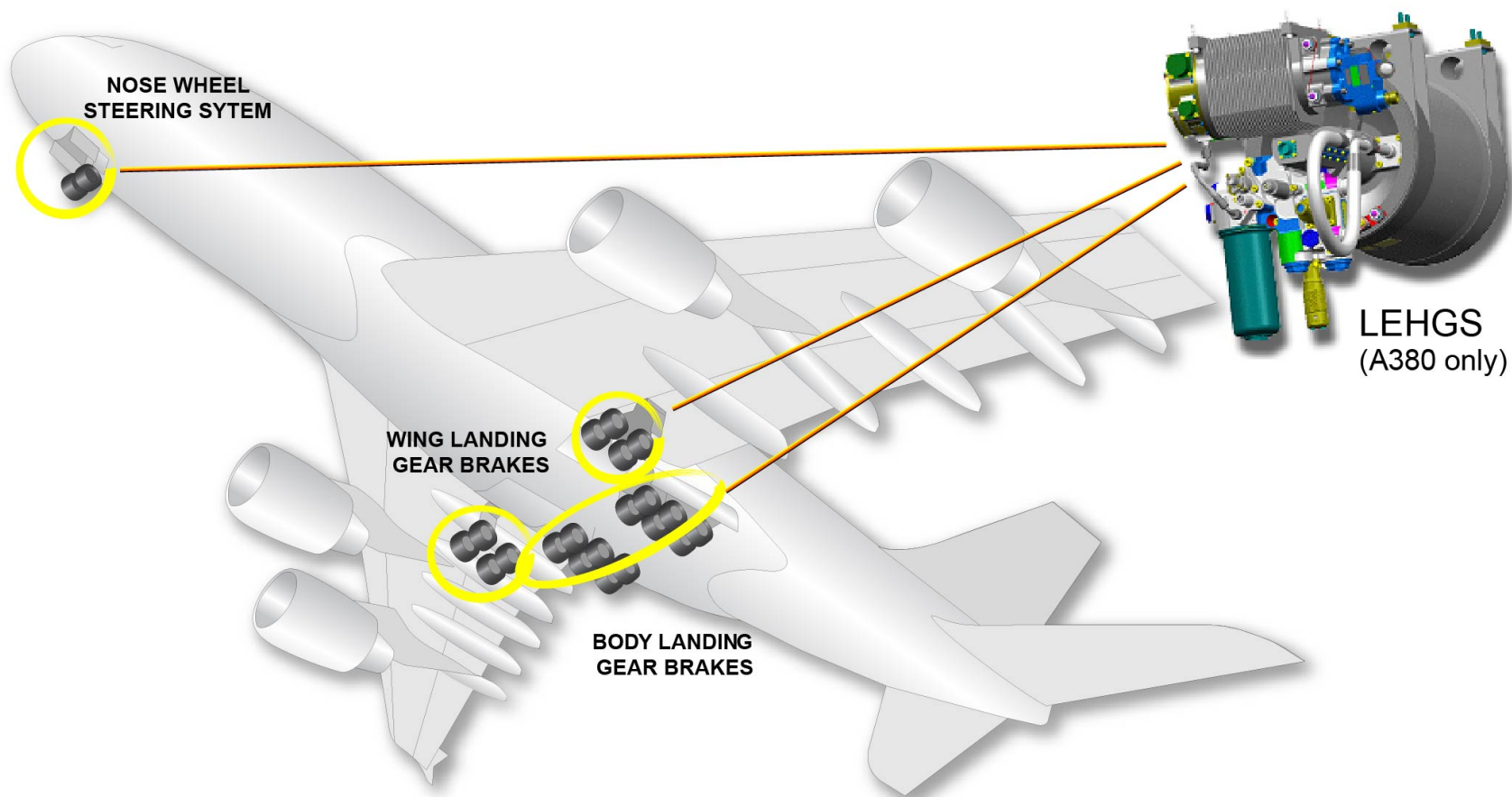
DEFINITION AND APPLICATION



DEFINITION AND APPLICATION



DEFINITION AND APPLICATION



DEFINITION AND APPLICATION

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ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

Actuators Of Primary Flight Control Surfaces

The A380 and A350 have three kinds of actuators:

- The conventional servocontrols,
- The Electro-Hydrostatic Actuators (EHAs),
- And, the Electrical Backup Hydraulic Actuators (EBHAs).

The conventional servocontrols are composed of:

- A hydraulic block connected to one hydraulic system of the aircraft,
- An actuator, composed of a fixed body attached to the aircraft structure, and a rod attached to the surface,
- A servovalve receiving orders from the flight control computers, which ports hydraulic pressure to translate the rod.

Electro-hydrostatic actuators (EHAs) are actuators which produce their own hydraulic pressure and can be used when the normal aircraft hydraulic pressure is lost.

The Electro-hydrostatic actuators (EHAs) are composed of:

- A hydraulic block,
- An actuator, same as a conventional servocontrol,
- An electro-hydraulic generation system.

The electro-hydraulic generation system receives orders from the flight control computers.

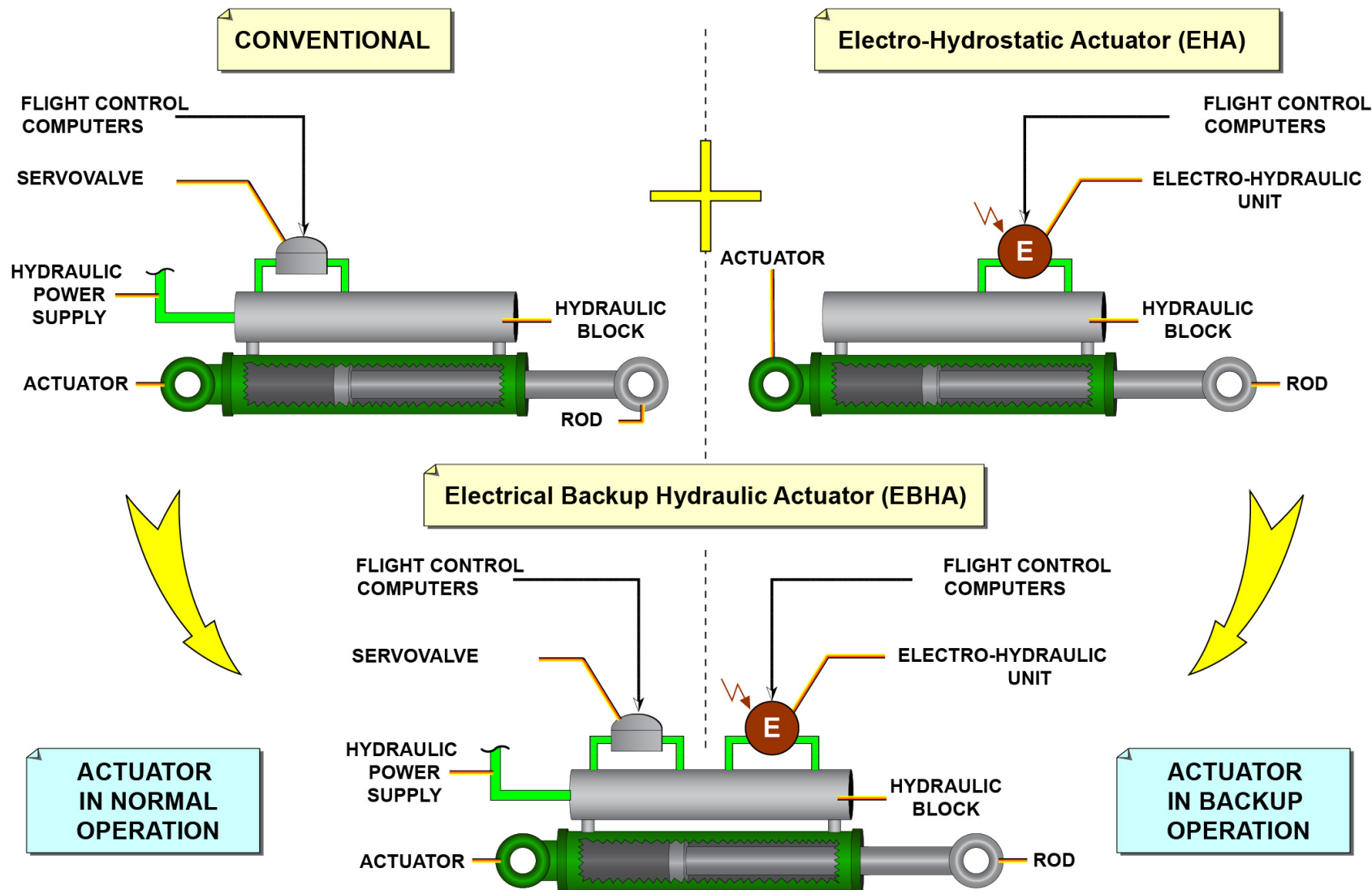
The direction of rotation of the electro-hydraulic generation system determines the direction of translation of the actuator rod.

The speed of the system determines speed of translation of the actuator rod.

Electrical Backup Hydraulic Actuators (EBHAs) are composed of a conventional servocontrol part and an EHA part controlling a common actuator.

During the normal mode of operation the EBHA operation is the same as a conventional servocontrol using aircraft hydraulic pressure to move the actuator rod.

If there is a loss of aircraft hydraulic pressure the EBHA acts the same way as an EHA, producing its own hydraulic pressure to move its actuator rod.



ACTUATORS OF PRIMARY FLIGHT CONTROL SURFACES

ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

EHA Description

An Electro-Hydrostatic Actuator (EHA) has the same function as a conventional servo-control actuator: to move a flight control surface. An EHA uses an electrically operated pump to generate its own hydraulic pressure. This pressure is supplied to the actuator piston to move the control surface.

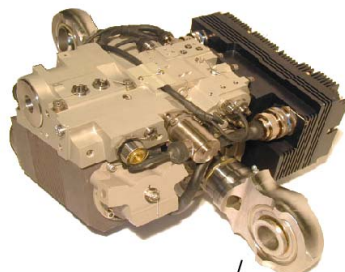
The Electronic Module (EM) is an interface between the Flight Control Computer and all components of the EHA. All control and monitoring signals go through the EM.

The accumulator contains the fluid reserve. It can be filled through a refill valve. It has a visual indicator.

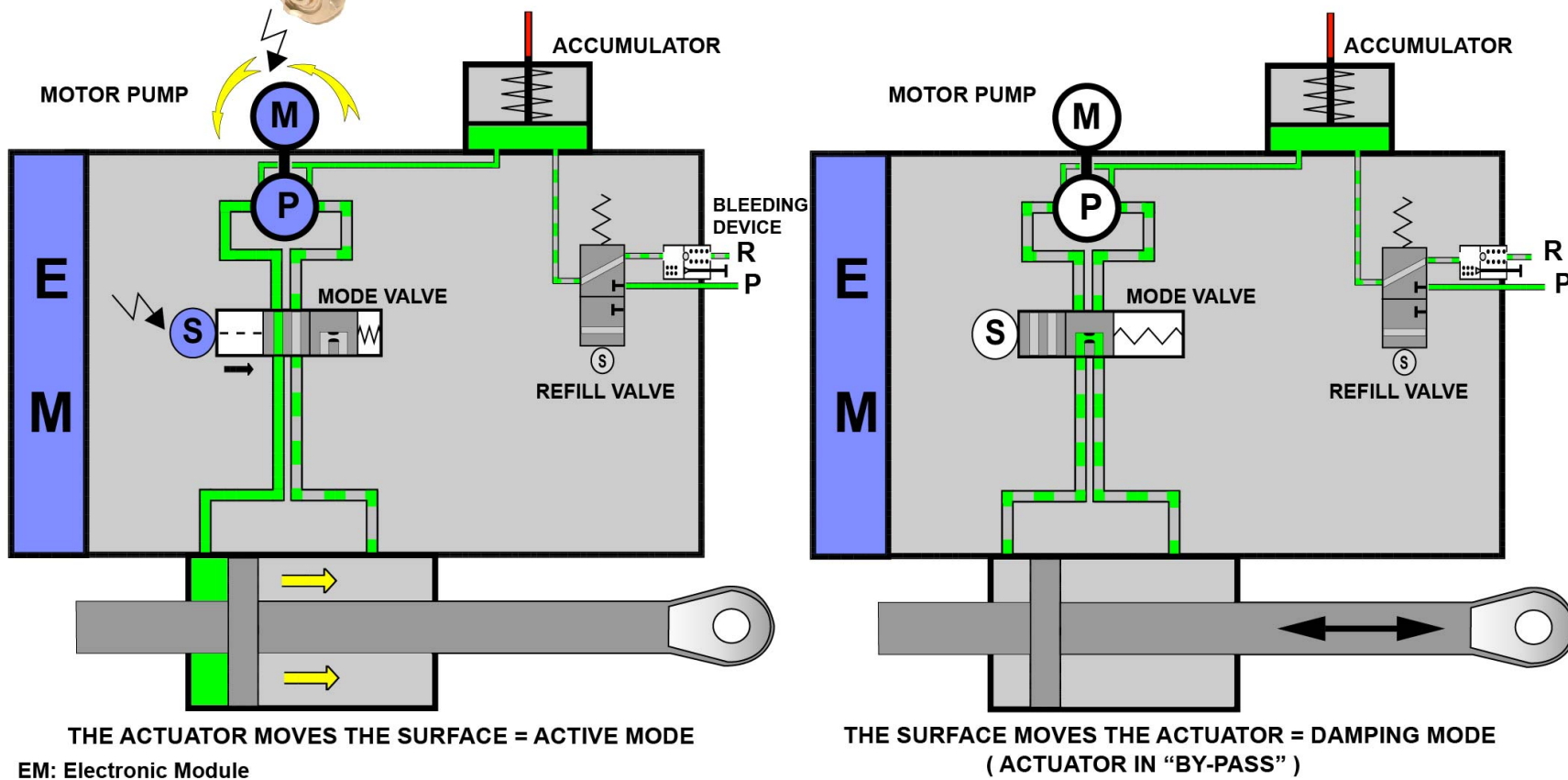
A motor pump supplies the fluid to extend or retract the actuator chamber at the necessary flow.

A mode valve is set to the active mode position when the EHA moves the surface or to the damping mode position when the surface moves the EHA.

A manual bleeding device is used to depressurize the EHA before a line disconnection or other type of maintenance task.



EHA : Electro Hydrostatic Actuator



EHA DESCRIPTION

ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

EHA Description (continued)

EHA Basic Components

The EHA includes the basic components of a servo-control:

- A fixed body, equal area ram, connected to the structure,

To obey the orders sent by the flight control computer, the EHA has:

- An electronic module,
- An electrical motor connected to a hydraulic pump which is complemented by an accumulator.

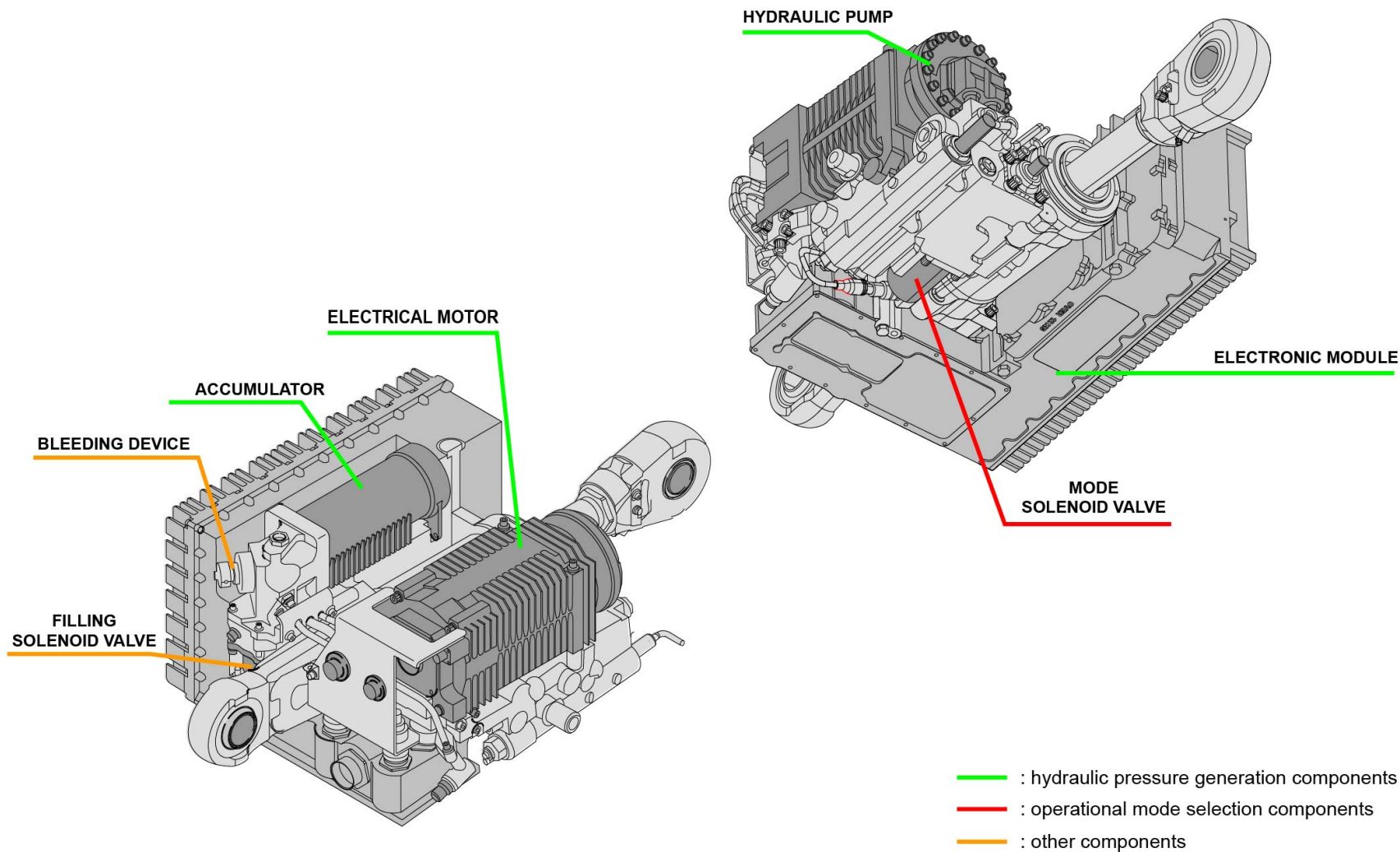
To operate the EHA, there is:

- A mode solenoid valve that is used for the selection of the damping or active operating modes.

Other components are necessary, such as:

- A commanded fluid-filling device that includes a solenoid filling valve and
- A device to do the EHA bleeding operation

EHA AILERON



EHA DESCRIPTION - EHA BASIC COMPONENTS

ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

EBHA Description

During normal operation, an Electrical Back-Up Hydraulic Actuator (EBHA) does the same function as a normal servo-control: it uses the aircraft hydraulic system pressure to move the flight control surfaces. If there is a failure of the normal hydraulic supply, the EBHA switches to its electrical back-up mode, and uses the electrically operated pump to generate and control the hydraulic pressure to the actuator. Thus, the operation of the EBHA in electrical back-up mode is the same as EHA operation.

The EBHA function is a combination of a conventional servo-control and an EHA.

The Electronic Module (EM) is an interface between the Flight Control Computer and all components of the EBHA. All control and monitoring signals go through the EM.

The accumulator contains the fluid reserve. It can be filled through a refill valve. It has a visual indicator.

A motor pump supplies the fluid to extend or retract the actuator chamber at the necessary flow.

A mode valve is set to the active mode position when the EBHA moves the surface or to the damping mode position when the surface moves the EBHA.



EBHA DESCRIPTION

ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

EBHA Description (continued)

EBHA External Components

The EBHA includes the basic components of a servo-control:

- A fixed body, equal area ram, connected to the structure,

In normal operation conditions, the EBHAs are connected to the aircraft hydraulic.

A hydraulic mode solenoid valve does the selection of the active operating mode.

A servo valve controls the hydraulic flow to the ram chambers.

In electrical back-up operation conditions, an electrical mode solenoid valve does the selection of the electrical active operating mode.

To generate their own pressure, the EBHAs have an electrical motor connected to a hydraulic pump.

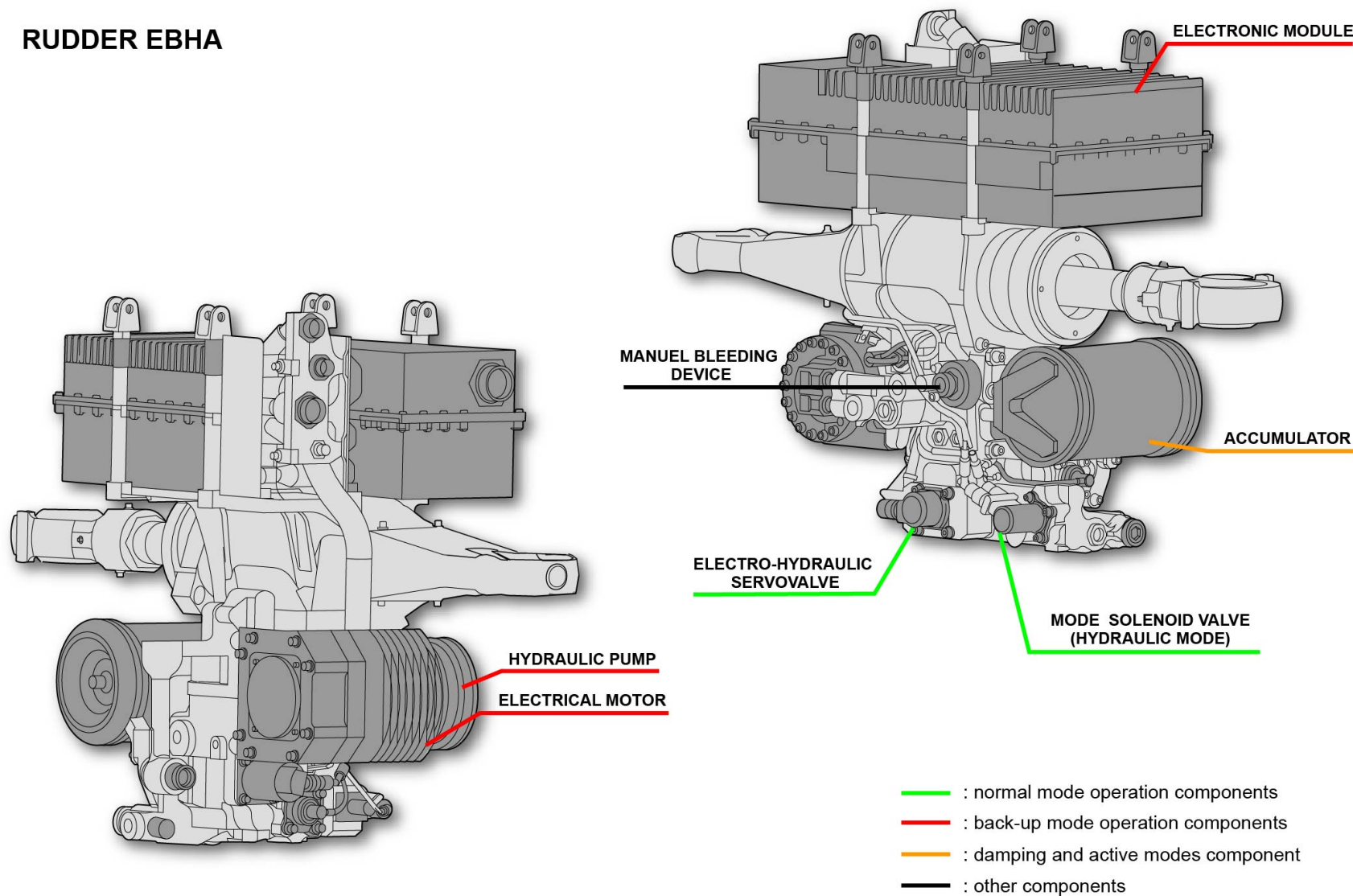
An electronic module controls and monitors the operation of the EBHA.

EBHA also includes:

- A metal bellow accumulator;

Other components are necessary, such as:

- A manual-bleeding device

RUDDER EBHA

EBHA DESCRIPTION - EBHA EXTERNAL COMPONENTS

ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

Digital Bus MIL 1553

On Airbus Fly By Wire (FBW) aircraft, communication between flight controls computers and actuators is "classic". Analog and discrete signals are used.

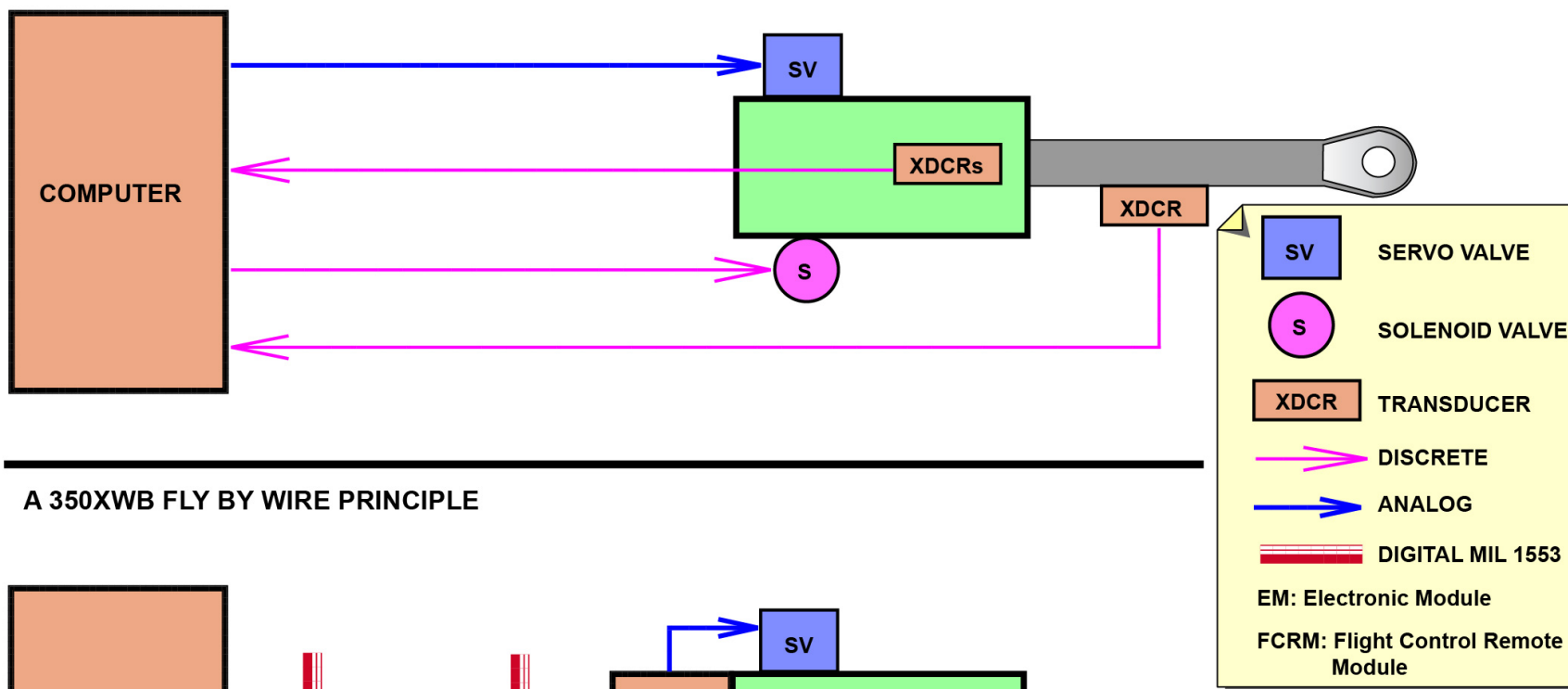
On A350 XWB, to give protection to the Flight By Wire network against indirect effects of lightning strike, electrical wires between computers and actuators use digital communication.

Each actuator has a Flight Control Remote Module (FCRM) or an Electronic Module (EM). The module is connected to the flight controls computers through a digital bi-directional bus (MIL 1553).

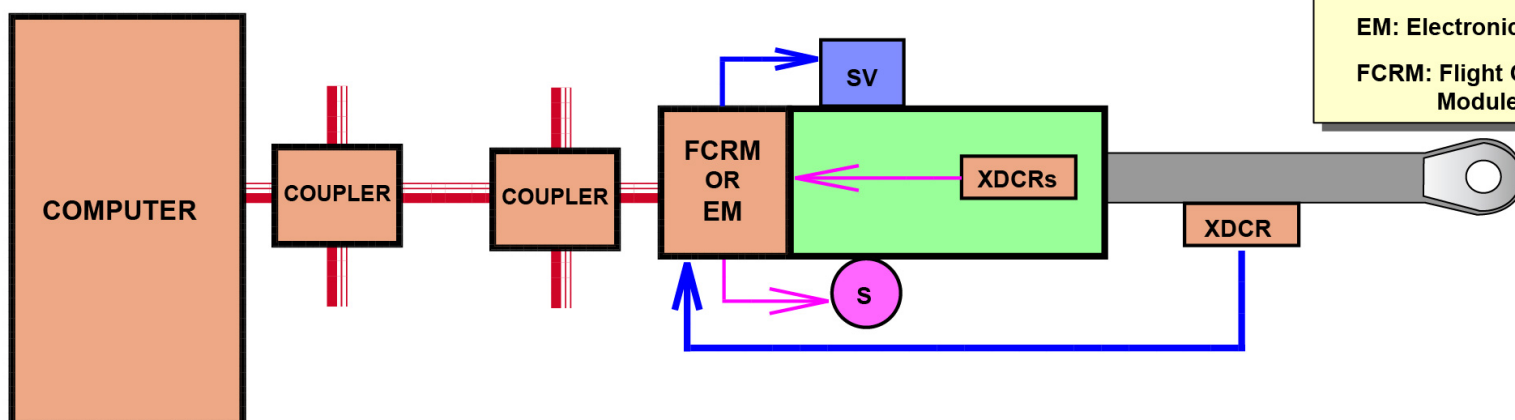
The function of the module is to convert digital signals into analog and discrete signals and vice versa.

It also does the actuator servo loop.

AIRBUS FLY BY WIRE PRINCIPLE



A 350XWB FLY BY WIRE PRINCIPLE



DIGITAL BUS MIL 1553

ELECTRO-HYDRAULIC SYSTEM: COMPONENTS

LEHGS Description and Operation

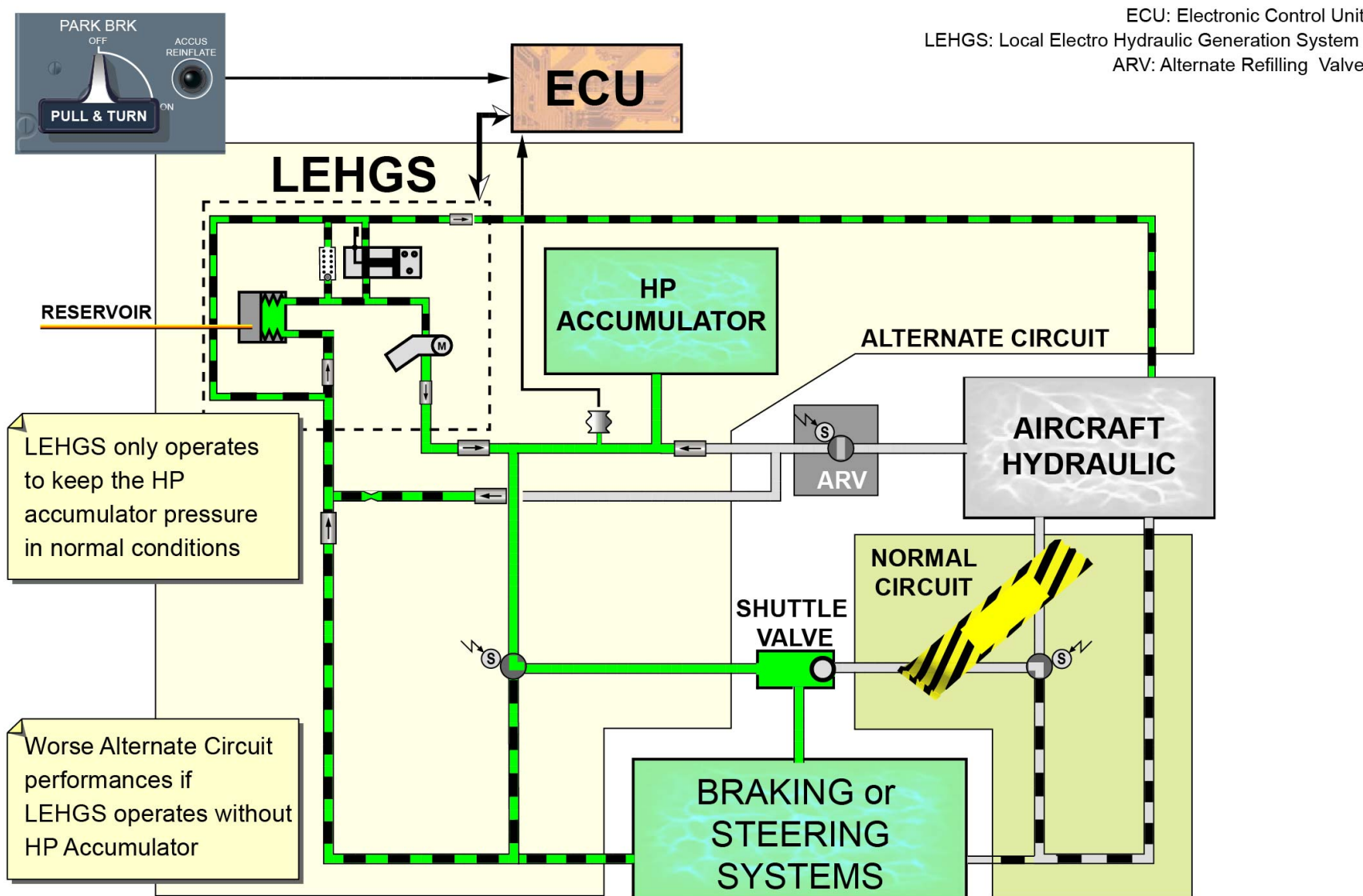
The Local Electro Hydraulic Generation System (LEHGS) is an electro hydraulic system which is energized and controlled by an Electronic Control Unit (ECU). The LEHGS supplies hydraulic power to the braking or steering system, through a shuttle valve, if normal hydraulic sources decrease below a pre-established threshold.

The LEHGS operates with an HP accumulator to meet the pressure and peak flow requirements of the alternate circuit. The LEHGS can operate autonomously from this accumulator, but the circuit performances will be decreased.

In normal configuration, the LEHGS will only operate to keep the accumulator pressure.

After engine start and when the aircraft hydraulic circuits are pressurized, the Alternate Refilling Valve (ARV) connected to the normal supply opens one time in each flight cycle to refill the HP Accumulator directly and the LEHGS Reservoir through a flow restrictor.

On the ground, with the engines off, the LEHGS commands from the ECU are inhibited, but it can be necessary to pressurize the alternate circuit, for example the parking brake accumulator. This function is done from one switch in the cockpit.



LEHGS DESCRIPTION AND OPERATION

XN113211 - X04NTT0 - XM29P3NEWTECH01

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

EHA / EBHA

In this module, EHA and EBHA maintenance activities will be shown together in this sequence:

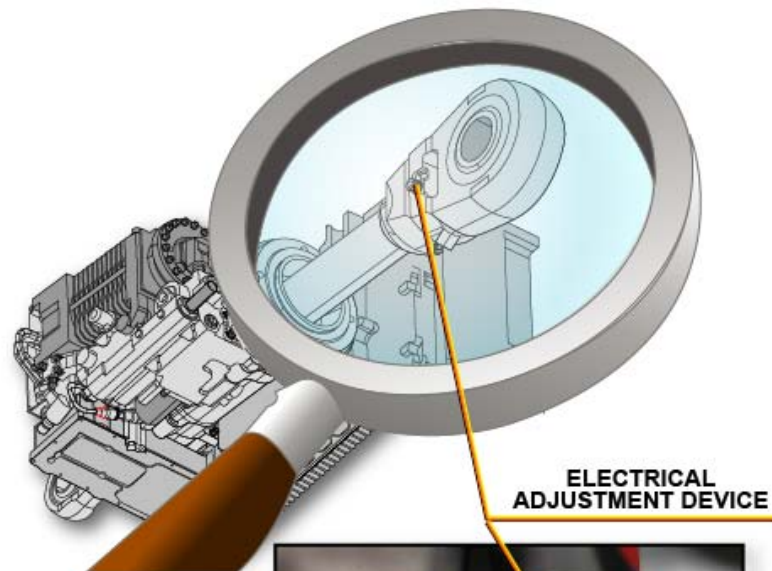
- Rigging on aircraft,
- Depressurization procedure,
- EHA and EBHA safety precautions,
- Replaceable components of these units in line.

Rigging On Aircraft

After the replacement on aircraft, the actuator length must be adjusted to agree with the surface position order sent by the Flight Control Computer. For the A380, the adjustment of the actuator length for a 0° position order is done through the rigging of the feedback transducer, with the dedicated mechanical adjustment device.

For the A350, EHA/EBHA rigging is done through a dedicated Onboard Maintenance Terminal (OMT) menu.

A surface position transducer rigging pin can also be used.



**A380 EHA/EBHA
RIGGING**



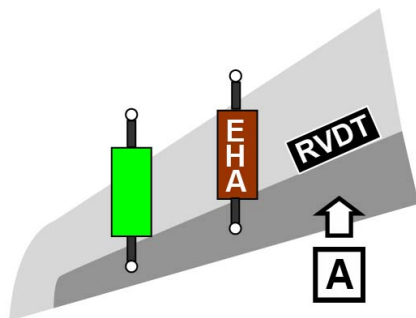
EHA / EBHA - RIGGING ON AIRCRAFT

XN113211 - X04NTT0 - XM29P4NEWTECH01

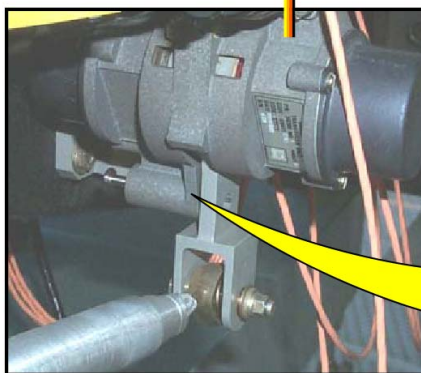


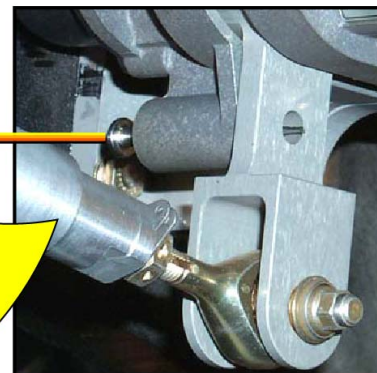
Onboard Maintenance Terminal

A350 EHA/EBHA RIGGING



SURFACE TO ADJUST

TRANSDUCER
UNIT

A

RIGGING
PIN


EHA / EBHA - RIGGING ON AIRCRAFT

XN113211 - X04NTT0 - XM29P4NEWTECH01

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ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

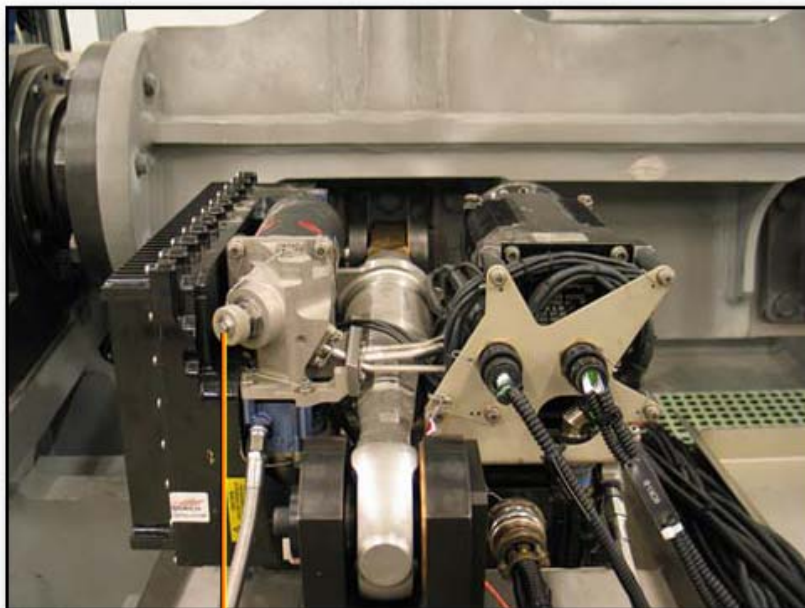
EHA / EBHA (continued)

Depressurization For Maintenance

Before a maintenance task, the hydraulic systems must be put in the depressurized-for-maintenance configuration. This is a protection to prevent injuries to the operators from hydraulic pressurization. The EHA/EBHA accumulator keeps a pressure inside the unit that can be dangerous. The Residual pressure in EHA/EBHA before bleeding is:

- 800psi (EHA),
- 400 psi (EBHA).

A hexagonal wrench must be applied to the manual bleeding device to remove fluid from the accumulator. This will release the internal pressure kept by the accumulator, and the maintenance operation will be done safely.

AILERON EHA

**MANUAL BLEEDING
DEVICE**
RUDDER EBHA


**Residual pressure in EHA /
EBHA before bleeding:**

- 800 psi (EHA)
- 400 psi (EBHA)

**MANUAL
BLEEDING
DEVICE**

EHA / EBHA - DEPRESSURIZATION FOR MAINTENANCE

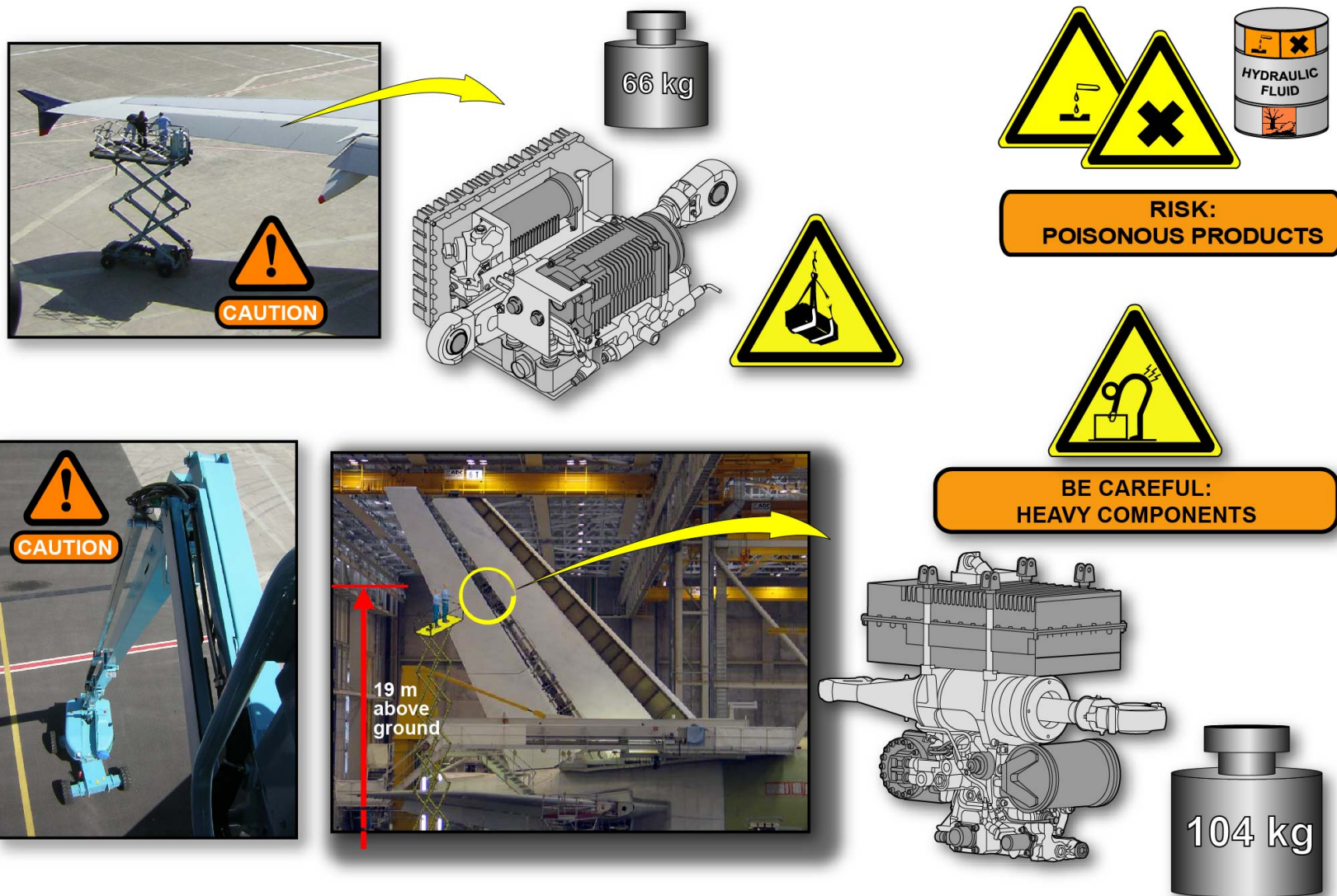
ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

EHA / EBHA (continued)

Safety Precautions

EHAs are installed on the elevators and the inboard and middle ailerons. Platforms must be used to do the removal/installation of EHAs and EBHAs which rudder type is 19 m above the ground on the A380. You must obey the safety regulations when you do work at some height, for example you must use a safety harness.

Because of the weight (104 kg for a rudder EBHA or 66 kg for an aileron EHA) and the possible height, you must use special tools and obey the safety precautions.


EHA / EBHA - SAFETY PRECAUTIONS

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

EHA / EBHA (continued)

Replaceable Components

Some components of the EHAs/EBHAs can be replaced on line in accordance with the documentationn, when all the safety procedures about hydraulic and electrical power are obeyed.

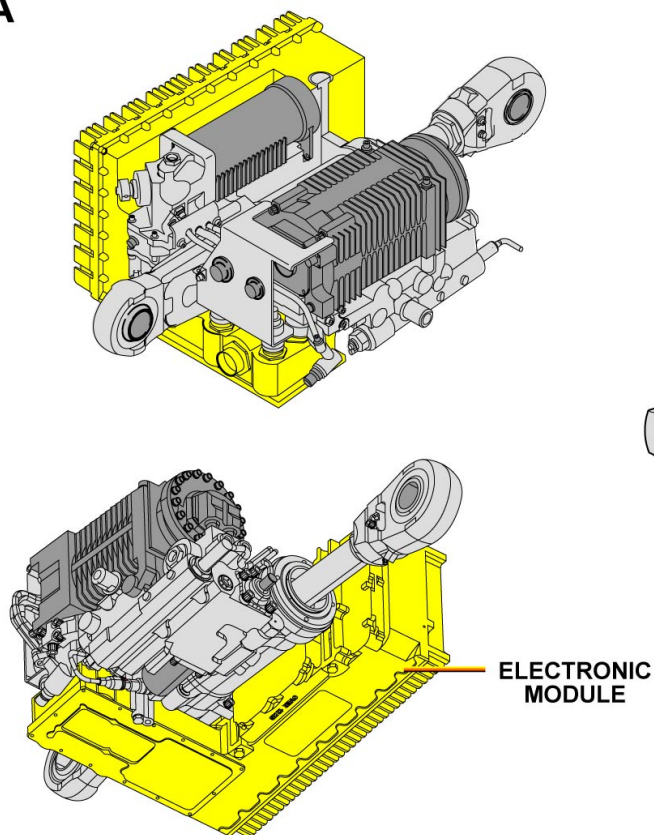
On the EHA, one component can be replaced:

- The Electronic Module.

On the EBHA, four components can be replaced:

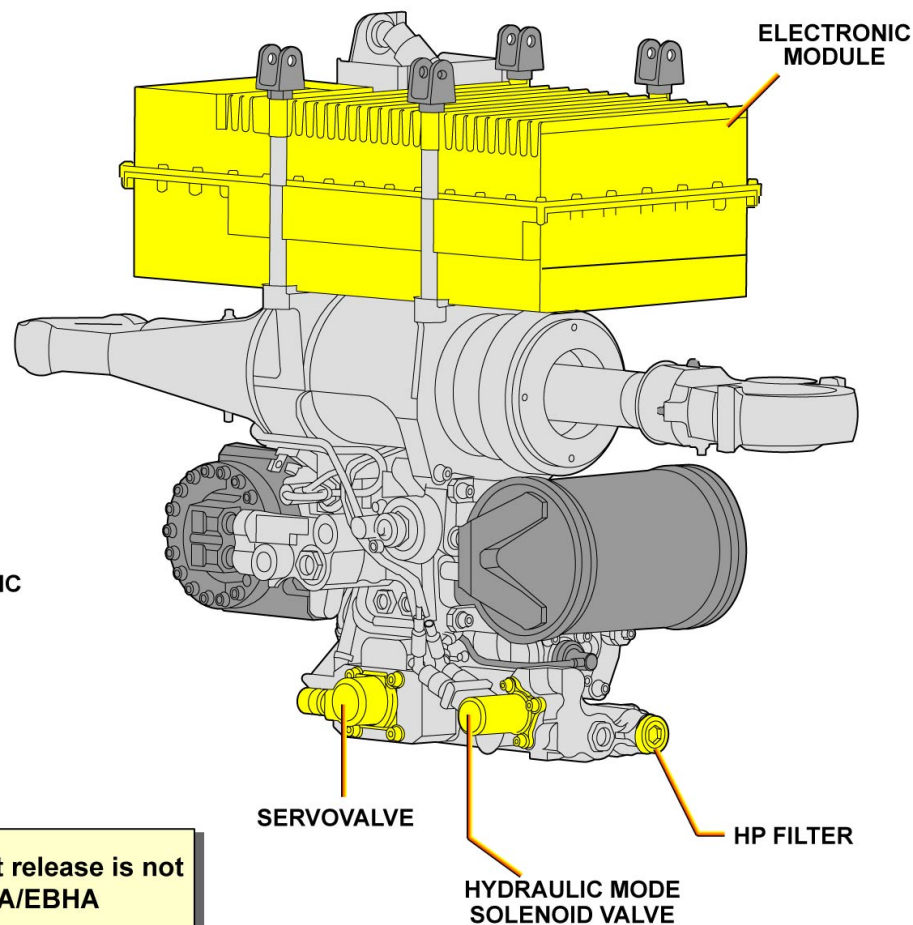
- The HP filter,
- The Electro Hydraulic Servo Valve (EHSV),
- The Hydraulic Mode Solenoid Valve,
- The Electronic Module.

According to MMEL, the aircraft release is not possible with a problem on an EHA/EBHA.

EHA


**ELECTRONIC
MODULE**

According to MMEL the aircraft release is not possible with a problem on EHA/EBHA

EBHA

EHA / EBHA - REPLACEABLE COMPONENTS

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

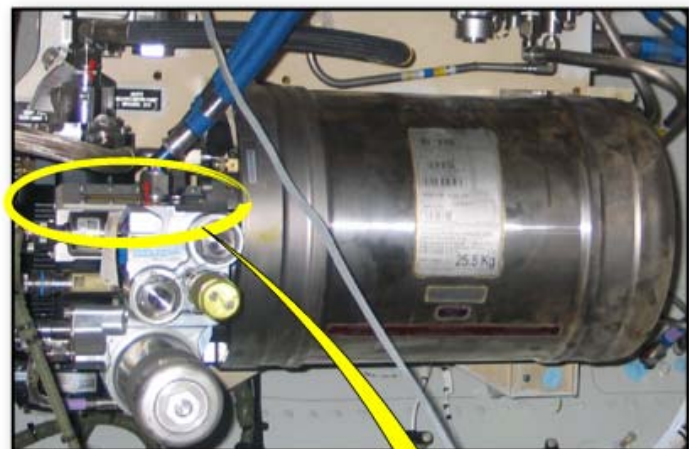
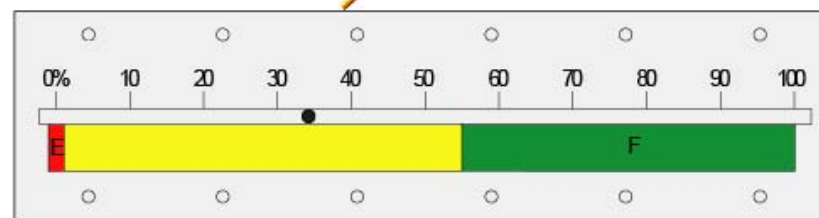
LEHGS (A380 only)

In this module, LEHGS maintenance activities will be shown in this sequence:

- Reservoir Level check,
- Reservoir depressurization,
- Filter Clogging,
- LEHGS Safety Precautions,
- Replaceable components of this unit.

Reservoir Level

A visual check of the reservoir level can be done through a visual indicator, which has one magnet installed on a rod connected to the bellow. The magnet moves a small ball in a glass groove. The ball position gives the indication of the reservoir level.


VISUAL INDICATOR

LEHGS (A380 ONLY) - RESERVOIR LEVEL

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

LEHGS (A380 only) (continued)

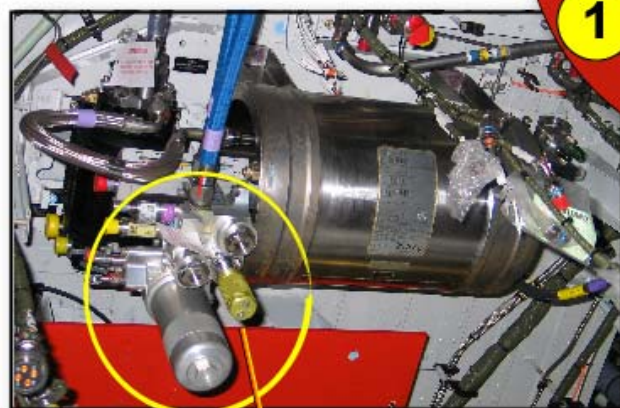
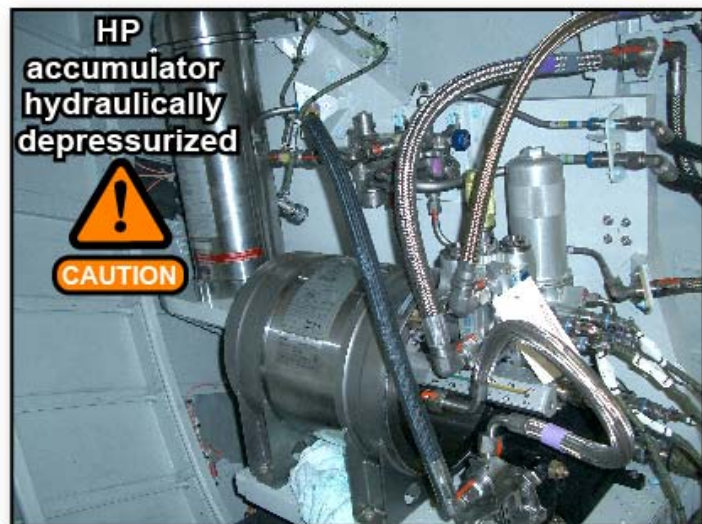
Reservoir Depressurization for Maintenance

The LEHGS operates in parallel with an HP accumulator. Thus, before you depressurize the LEHGS reservoir, make sure that the HP accumulator is depressurized.

The Low Pressure Relief Valve includes a manual depressurization handle that depressurizes the reservoir if maintenance is necessary. To do this, turn it fully counterclockwise and hold it in this position for a minimum of 20 seconds.

Then, release the manual depressurization handle and make sure that the internal spring turns it fully clockwise to its initial position. Make sure that the LEHGS reservoir visual indicator is in the Red zone.

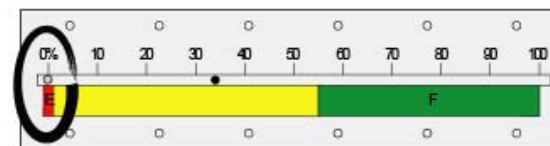
To re-pressurize the LEHGS reservoir and the HP accumulator, it is necessary to pressurize the general hydraulic system and open the alternate refill valve. This will be explained in more detail in the type-rating course.



**MANUAL HYDRAULIC
DEPRESSURIZATION
HANDLE**



> 20 s.



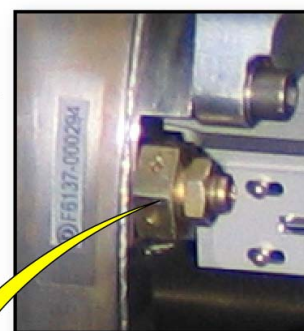
LEHGS (A380 ONLY) - RESERVOIR DEPRESSURIZATION FOR MAINTENANCE

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

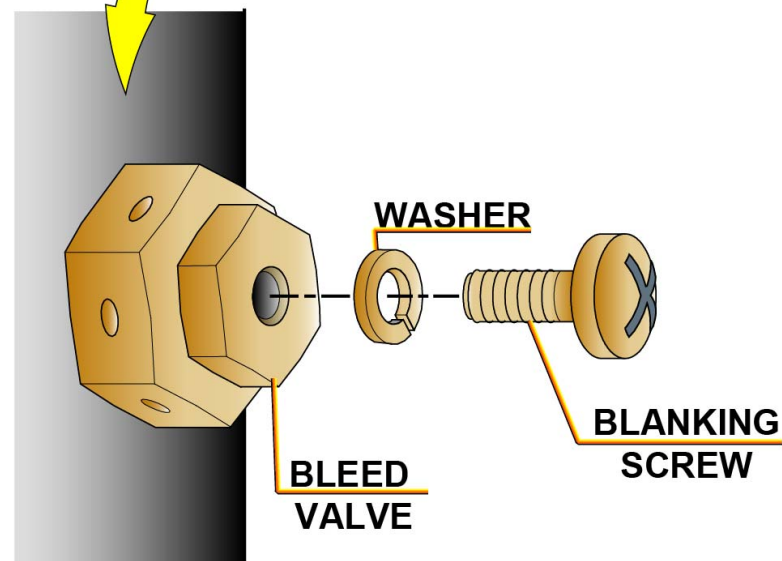
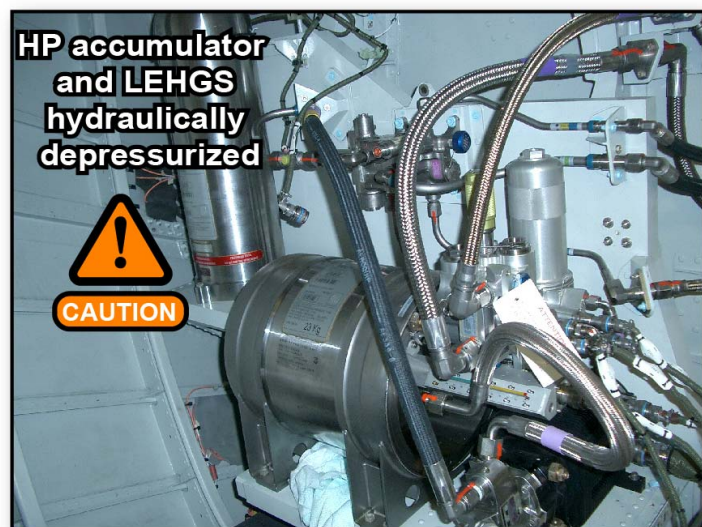
LEHGS (A380 only) (continued)

Bleeding

Before you bleed the LEHGS and the related high-pressure accumulator, make sure that the LEHGS reservoir and the related high-pressure accumulator are de-pressurized. There are 4 bleeding points on the LEHGS unit: 2 on the motor-pump and 2 on the reservoir to bleed air and hydraulic fluid. It is necessary to remove the blanking screw and the washer to get access to the bleed valve.



BLEEDING POINT



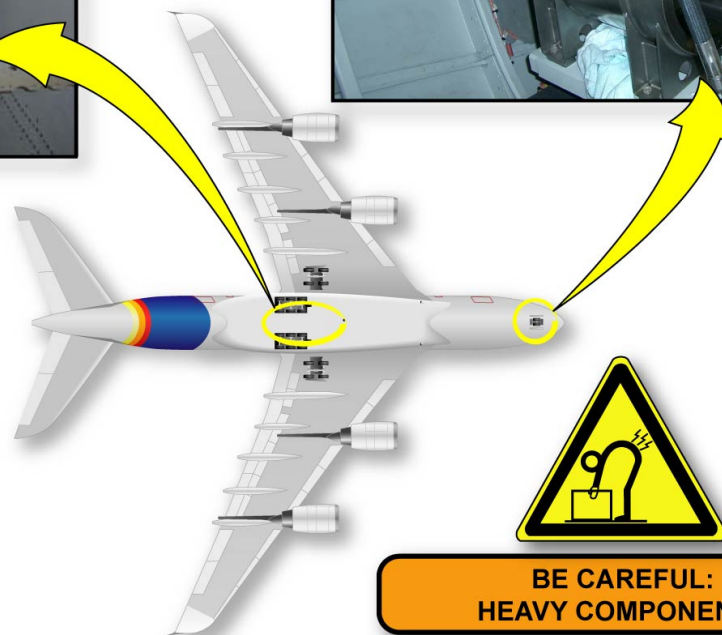
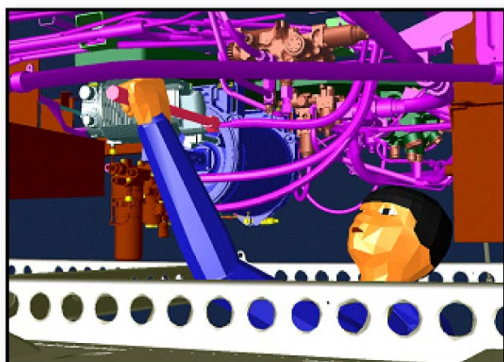
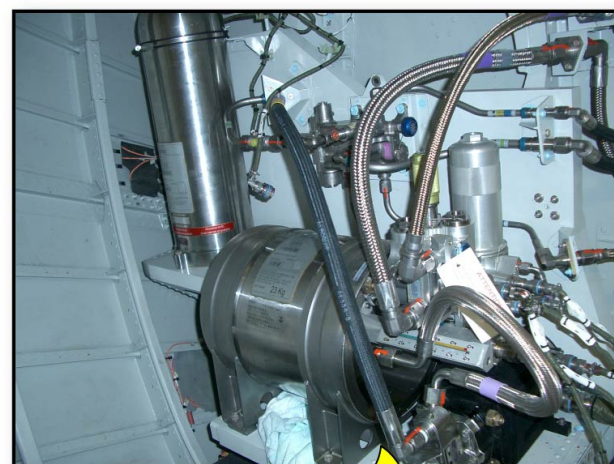
LEHGS (A380 ONLY) - BLEEDING

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

LEHGS (A380 only) (continued)

LEHGS Safety Precautions

LEHGS LRUs are light compared to other systems, but it is highly recommended to use platforms for their removal/installation because of the health and safety concerns related to work done above a specified height.



**BE CAREFUL:
HEAVY COMPONENTS**

LEHGS (A380 ONLY) - LEHGS SAFETY PRECAUTIONS

ELECTRO-HYDRAULIC SYSTEM: MAINTENANCE OPERATIONS

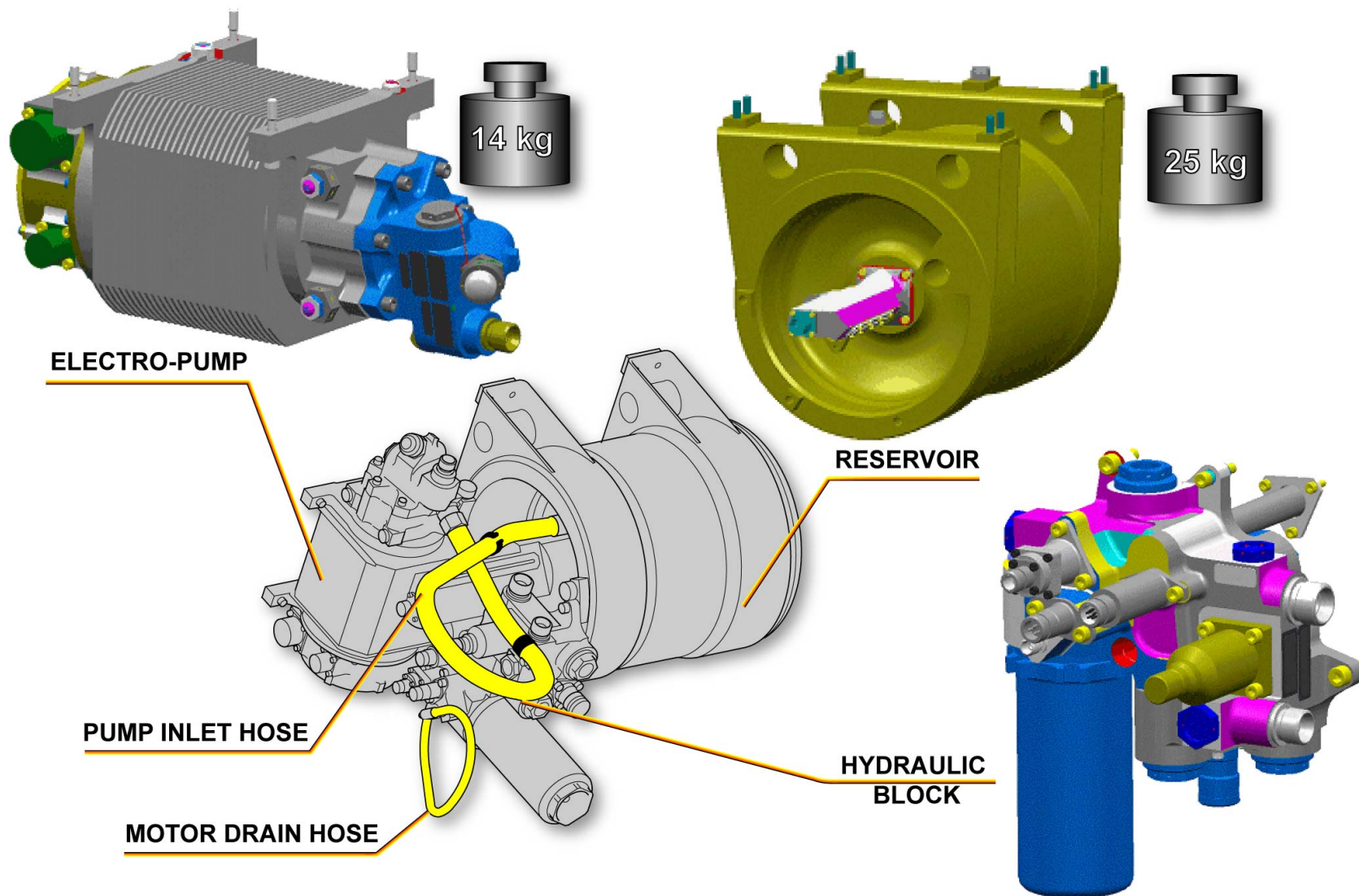
LEHGS (A380 only) (continued)

Replaceable Components

The LEHGS unit has 5 Line Replaceable Units (LRUs). These are:

- The reservoir, which has a weight of approximately 25 kg,
- The Motor Pump assembly, which includes a motor and pump with clogging indicator & filter, and which has a weight of approximately 14 kg,
- The Hydraulic block assembly, which includes a clogging indicator, a manifold (which contains 3 check valves, a maintaining valve, a Low Pressure Relief Valve and a By-pass Valve), a Return selector valve, a Low Pressure filter, a temperature sensor and a Reservoir Pressure Transducer,
- The Motor Drain Hose,
- The Pump Inlet Hose.

The weights given do not include the fluids.



LEHGS (A380 ONLY) - REPLACEABLE COMPONENTS

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

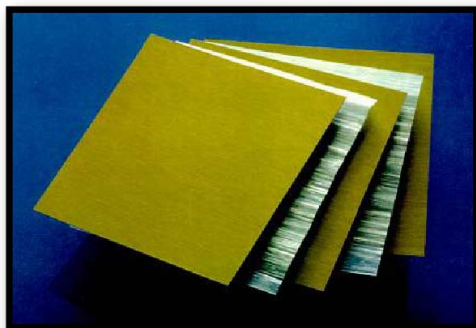
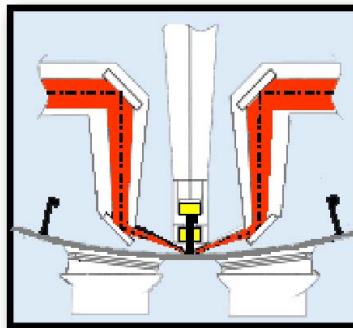
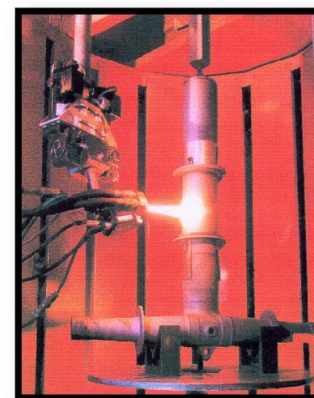
Introduction

The new Airbus aircraft give the opportunity to use new concepts, materials and processes, that will meet the design criteria and industrial requirements to give the highest benefit to the aircraft. GLARE, Laser Beam Welding and High Velocity Oxygen Fuel are examples of them.

NEW CONCEPTS
NEW MATERIALS
NEW PROCESSES

-to meet the design criteria and
the industrial requirements

-to give the highest benefit to the aircraft


GLARE

LASER BEAM WELDING

**HIGH VELOCITY
OXYGEN FUEL**
INTRODUCTION

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

GLARE

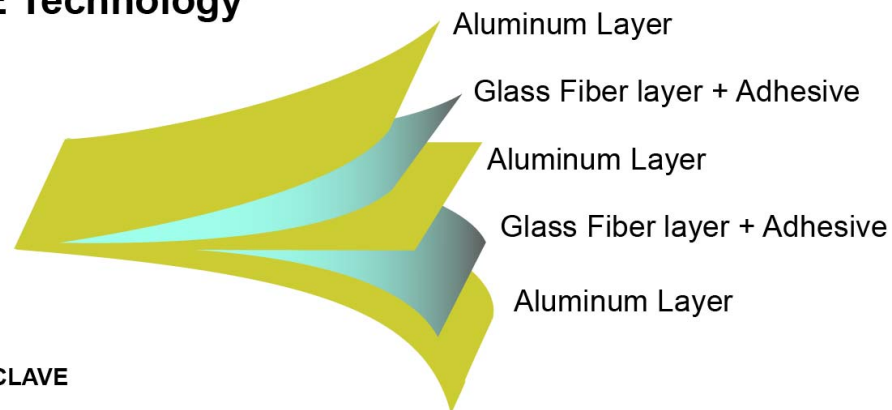
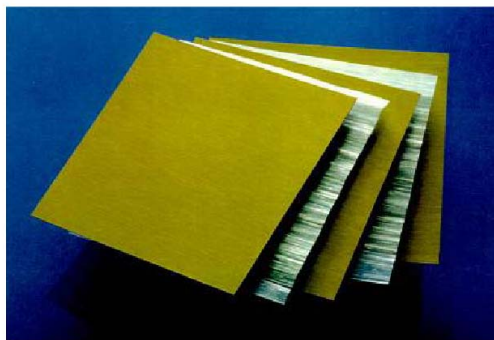
BASIC PRINCIPLE

GLARE is a multilayer sheet material.

It is made from alternate layers of Aluminum thin foils and layers of unidirectional glass fibers impregnated with an epoxy-based adhesive. With its glass fibers, GLARE has better mechanical properties than the Aluminum alloys. The aluminum foils prevent moisture absorption into the glass fiber layers.

Like other composite materials, the different layers are applied on a specific mold. The completed GLARE lay-up and its mold are put into an autoclave for the curing-cycle. At the end of the curing process, the new part is removed from the mold and can be used for the final machining.

GLARE Technology



AUTOCLAVE



GLARE LAY UP



GLARE SKIN PANEL



GLARE SKIN PANEL

GLARE - BASIC PRINCIPLE

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A380 STRUCTURE: PRESENTATION AND ADVANTAGES

GLARE (continued)

Benefits

There are almost no changes in the machining process and repairing procedures of GLARE parts compared to Aluminum alloys.

From a mechanical point of view, the glass-fiber barrier function gives to the GLARE material a higher level of corrosion resistance than aluminum alloy specimens that would fully corrode.

This glass-fiber barrier function also gives a higher level of lightning strike resistance than aluminum material of the same thickness.

GLARE also has a higher resistance to fire.

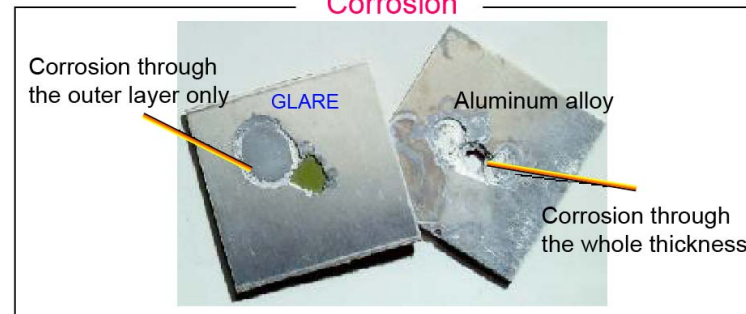
GLARE and aluminum alloys have approximately the same resistance to cracking after impact damage, although GLARE has a better resistance to high velocity impacts. GLARE also has better properties than composites for all types of impact damages. If a crack occurs, it will increase less quickly than on an aluminum panel.

GLARE BENEFITS

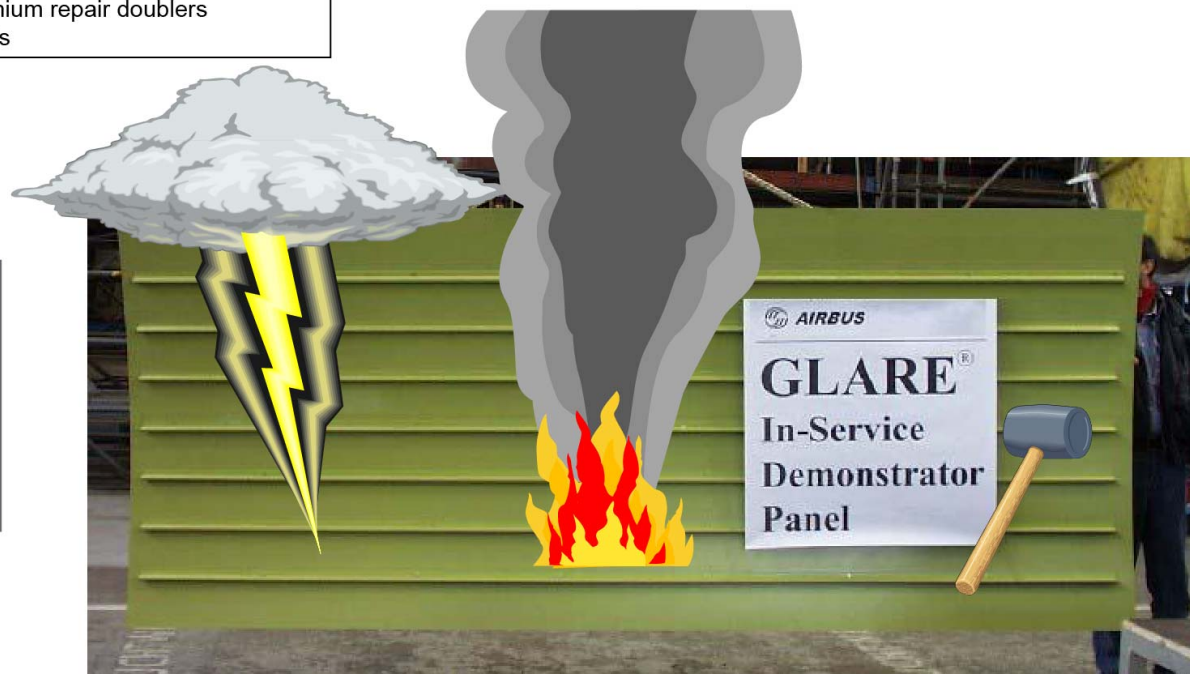
Repairing



Corrosion



- Higher Corrosion Resistance
- Higher Lightning Strike Resistance
- Higher Fire Resistance
- Higher Impact Resistance
- Slower Crack Growth



GLARE - BENEFITS

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

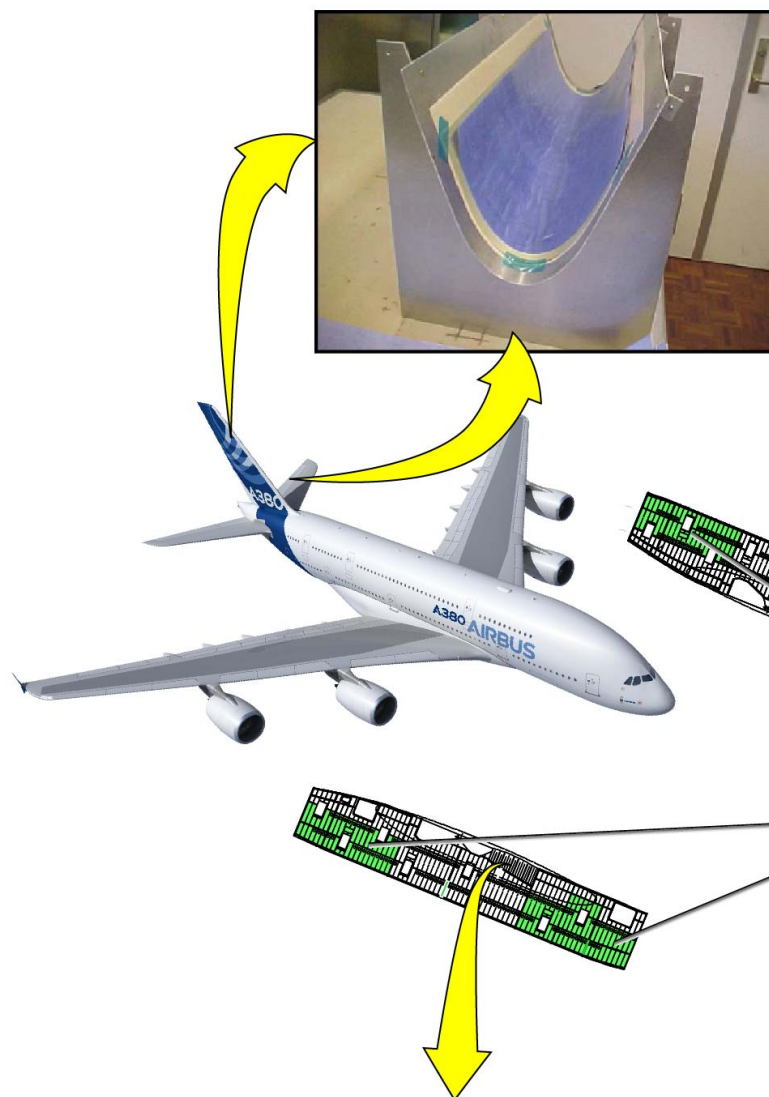
GLARE (continued)

Application

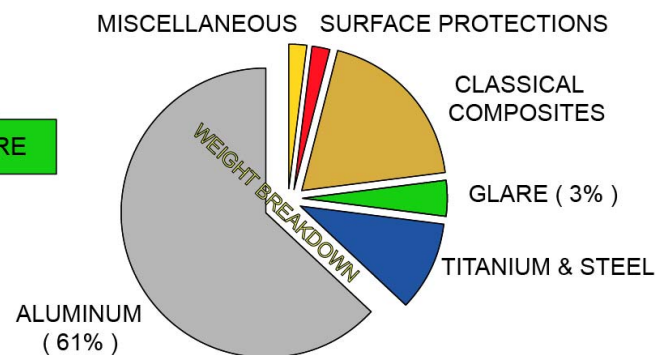
GLARE technology is used to replace the typical aluminum skin panels of the upper and lateral parts of the fuselage. GLARE meets the design criteria for high strength performances, higher damage tolerance and lower weight.

It is also used in the leading edge of the vertical and horizontal stabilizers.

Approximately 500 square meters of GLARE skin are used in the A380. GLARE has a lower density than panels made from Aluminum sheet material, which causes a weight saving of approximately 12%. GLARE is mainly used in the areas loaded in fatigue, because it has better properties in these areas than aluminum monolithic parts.



12 % WEIGHT SAVING



GLARE - APPLICATION

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

Laser Beam Welding

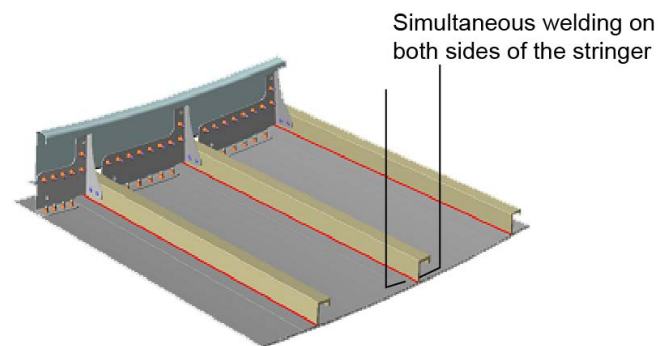
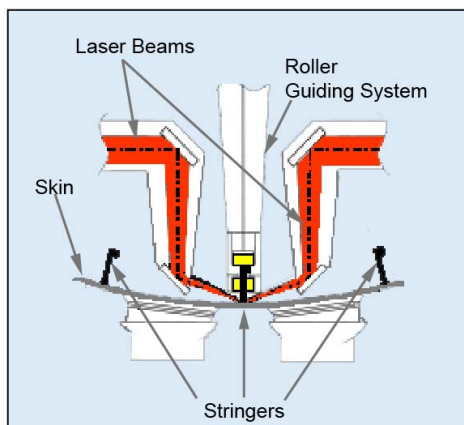
Basic Principle

Laser Beam Welding is a new welding process in which a laser is projected along the lower area of the stringer and welds the stringer to the skin.

This automatic process welds the two sides of the stringer at the same time.

This new concept of stringers-and-skin structure is an integral structure, and not an assembled structure as before.

Laser Welding Process



Integral Structure

LASER BEAM WELDING - BASIC PRINCIPLE

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

Laser Beam Welding (continued)

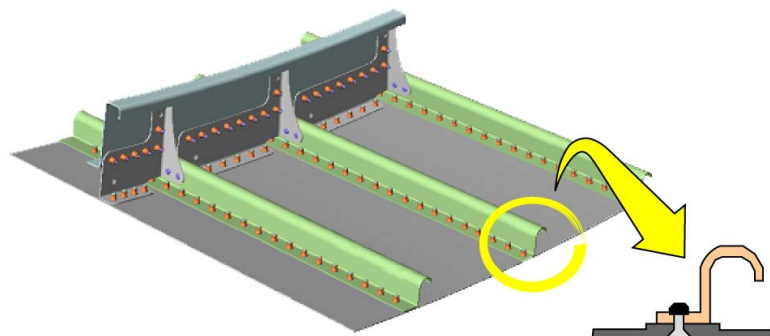
Benefits

The Laser Beam Welding will replace the riveting process to attach the stringers to the skin, with a very good quality of the welding joint. With the riveting process, the speed was not more than 0.15 - 0.25 meters per minute. With the new system, you can have a speed between 8 -10 meters per minute. The rate of crack growth is also lower because no holes are necessary for riveting.

This welding process does not decrease the skin mechanical properties. The products made with this process are stronger and less heavy, because no fasteners, sealants or rivets are used. The manufacturing costs are also lower.

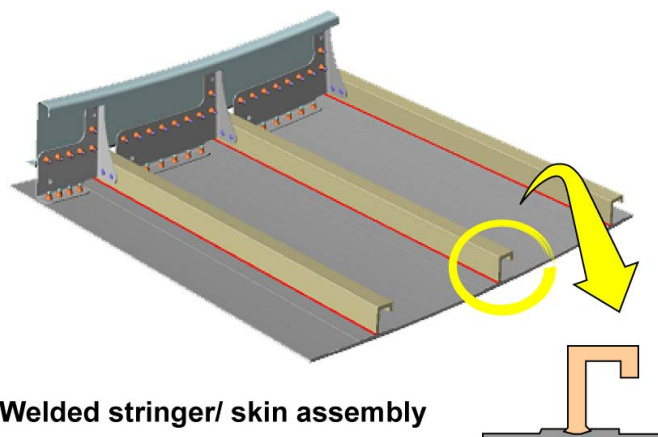
The laser beam welding technology gives higher corrosion resistance to weldable aluminum alloys. With this technology, the final product is manufactured as an integral component that has better anti-corrosion properties.

Rivet speed: 0.15 - 0.25 m / min

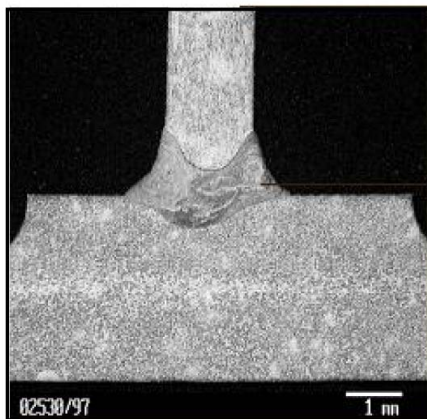


Typical riveted stringer/skin assembly

Weld speed: 8 - 10 m / min



Welded stringer/ skin assembly



Benefits

- Slow crack growth
- Skin not affected by welding
- Weight Saving
- Manufacturing Cost Reduction
- Development of weldable aluminum alloys higher corrosion resistance
- Final product as an integral component



LASER BEAM WELDING - BENEFITS

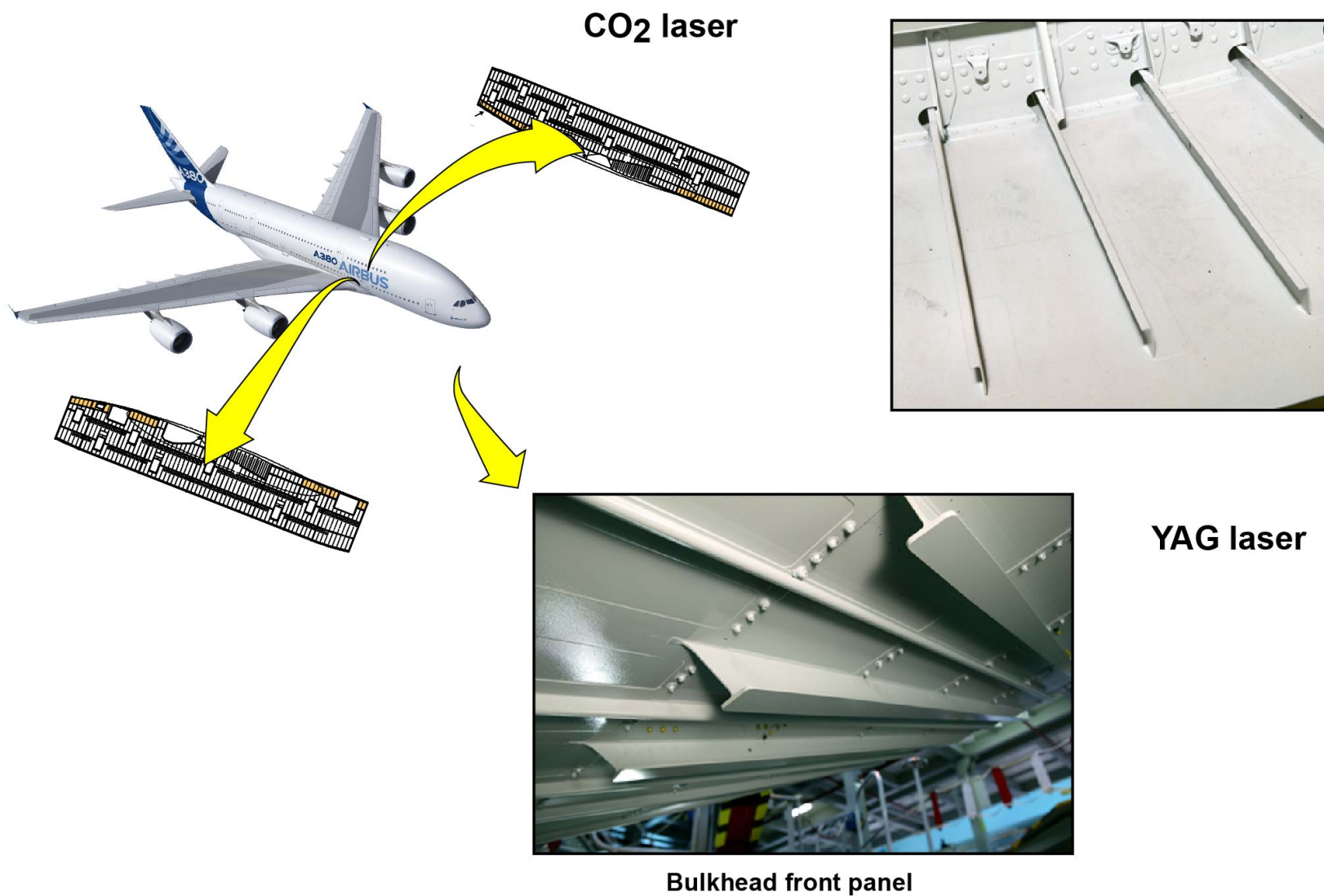
A380 STRUCTURE: PRESENTATION AND ADVANTAGES

Laser Beam Welding (continued)

Application

The CO2 laser welding process is used to attach the skin to the stringers on the lower fuselage skin panels. This process is used on single curved and double curved panels.

A second type of laser welding, the YAG laser (Yttrium-Aluminum-Garnet), is also used to weld the stringers to the bulkhead front panel.



LASER BEAM WELDING - APPLICATION

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

Laser Beam Welding (continued)

physical principle of the co2 laser

The gases and the mixture for CO2 laser are supplied in cylinders. The mixture contains helium, nitrogen and carbon dioxide. For aluminum, helium-argon mixtures are usually recommended. The laser beam can be transmitted through the air, without the need of a vacuum. This feature simplifies the equipment, the organization and reduces the operation costs compare to other welding processes. Nevertheless, it is necessary to protect the heated material surface and the molten from the reaction with the atmosphere.

Few gases provide total surface protection, argon and helium are possible and sometimes the nitrogen is also used with this objective. It is necessary also to control the plasma formation in case of high-power CO2 laser, thanks to the helium present in the mixture. The plasma is a cloud of ionized metal vapor and gases that can be formed in the point of welding. This cloud affects the laser radiation and could interrupt the laser process.

To perform the welding, the electromagnetic radiation comes in contact with the base metal surface, with such an energy concentration, that the surface is melted and volatilized.

The pressure of the vapor displaces the molten metal forming a cavity. This cavity supports the transfer of the laser energy and guides the laser beam into the material allowing very deep and narrow welds. During the process, there are a very important temperature differential between the molten metal and the base metal immediately adjacent to the weld.

In general the laser can be controlled very precisely. It can be directed by special optical lenses and mirrors, to make this process especially suitable for narrow and deep joints.

The laser is focused by means of copper mirrors and guided to the welding point. To get that, the welding heat follows the contours of

the components. Even with complex geometry, the laser operates with ten different axes (5 + 5 at the surface and at the laser beam).

When the system is welding the stringers to the skin panels, instead of the laser light, you see two small red dots, which run along the same path than the invisible laser beam, welding the stringer on both sides simultaneously.

With this welding way, very little heat is introduced into the component, as it produces a very thin welding.

physical principle of the YAG laser

The principle of the system is the heat conduction welding.

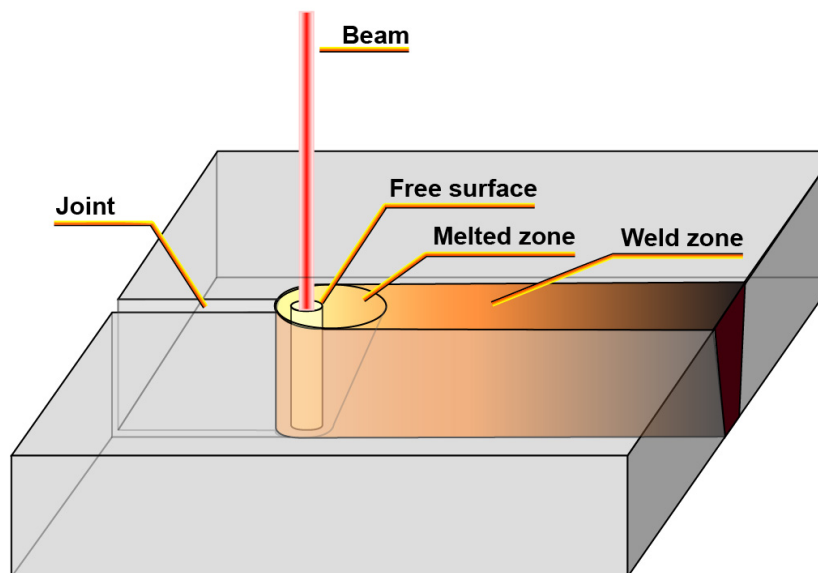
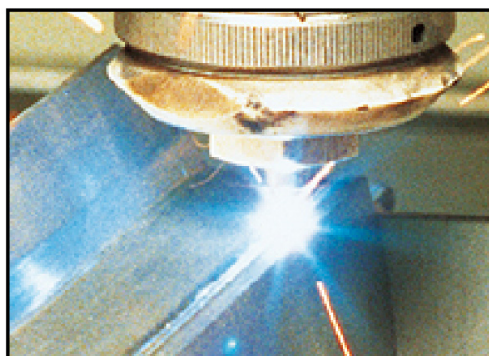
The laser beam is focused on the joint with the help of a mirror or a lens, heating the work piece locally.

The intensity is sufficient to melt the material, but not enough to vaporize it. The materials melted flow into one another, and solidify into a mutual welding point or mutual welded seam.

When heat conduction is used, to weld components, the welding depth is limited to only a few tenths of a millimeter.

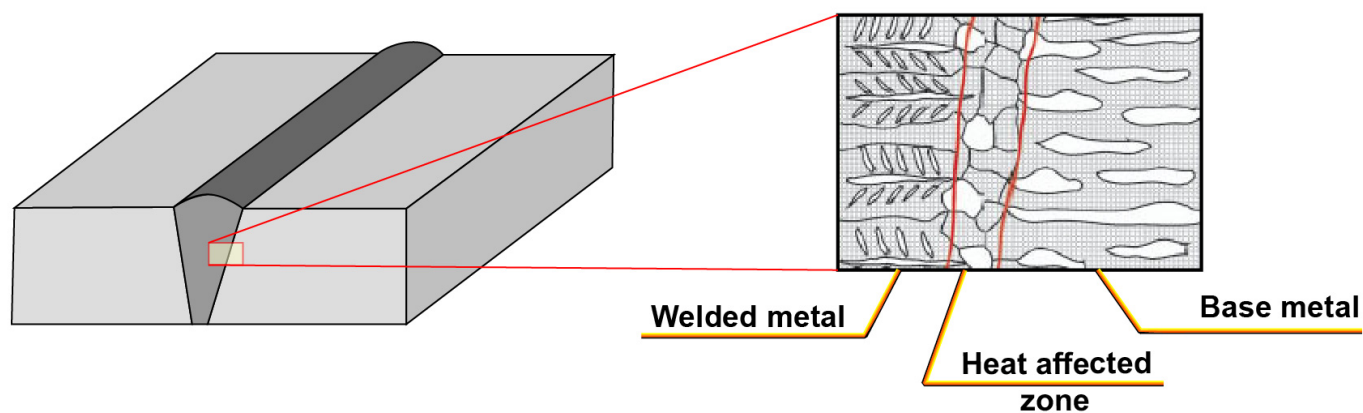
For this procedure, the aluminum alloy Al 6056 -T78 is used.

PHYSICAL PRINCIPAL



The surface is melted and volatilized

Important differential temperature between the zones



LASER BEAM WELDING - PHYSICAL PRINCIPLE OF THE CO2 LASER & PHYSICAL PRINCIPLE OF THE YAG LASER

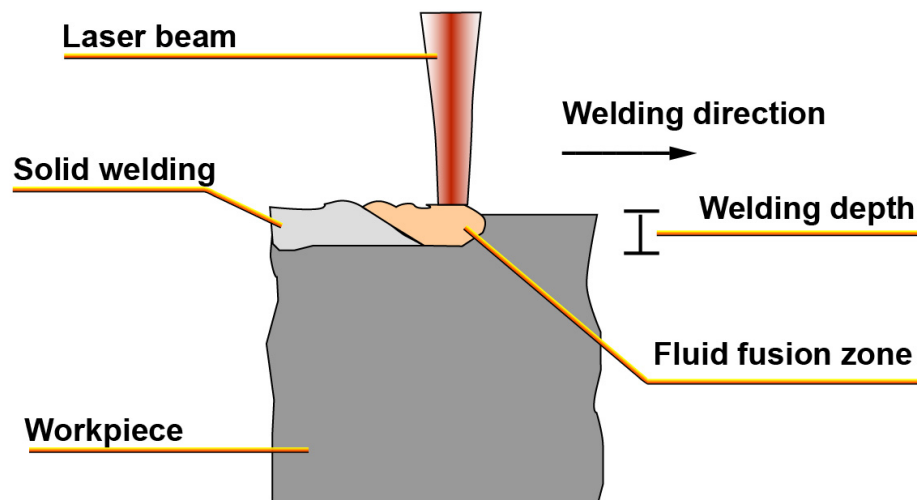
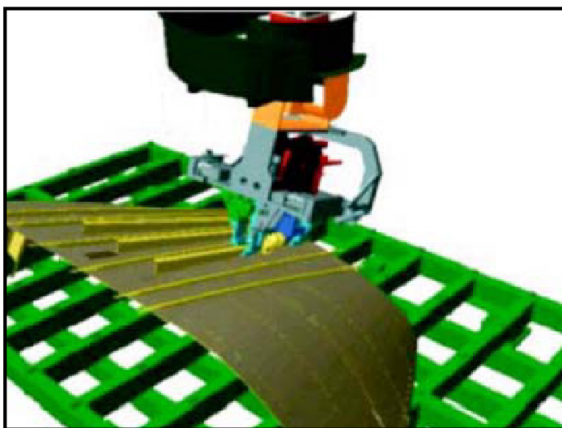
YAG LASER PRINCIPLE

It is based in the heat conduction welding

The laser beam is focused on the joint

The material is melted but not vaporized

The welding depth is limited to tenths of a millimeter.



Aluminum alloy 6056 - T 78

LASER BEAM WELDING - PHYSICAL PRINCIPLE OF THE CO2 LASER & PHYSICAL PRINCIPLE OF THE YAG LASER

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A380 STRUCTURE: PRESENTATION AND ADVANTAGES

High Velocity Oxygen Fuel

Basic Principle

The High Velocity Oxygen Fuel is a thermal surface treatment. In this treatment, a high-pressure gas stream, produced by internal combustion in a gun, accelerates powder particles of tungsten carbide cobalt and causes their impact against the surface to treat.

THERMAL SURFACE TREATMENT



A high pressure gas stream
accelerates particles of carbide cobalt



HIGH VELOCITY OXYGEN FUEL - BASIC PRINCIPLE

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

High Velocity Oxygen Fuel (continued)

PHYSICAL PRINCIPLE

The process begins when the fuel in liquid state and the oxygen, are fed at high pressure via a premixing system into a combustion chamber, inside the gun, where is produced a chemical reaction.

The quantity of any component is controlled automatically with specific equipment from the outside.

The fuel can be composed of varying mixtures of kerosene, acetylene, propylene and hydrogen, depending on user coating requirements, to get the highest possible quality.

Once they are inside, a chemical reaction takes place. The powder particles are included later through a powder feeder.

Due to the high temperature produced by the chemical reaction, the gun must be cool down; this is done through an internal water stream. The increase in temperature and the pressure generated inside the gun by the chemical reaction, produce a very energetic gas stream and very high velocities in which will be inserted the powder particles chosen to treat the surface.

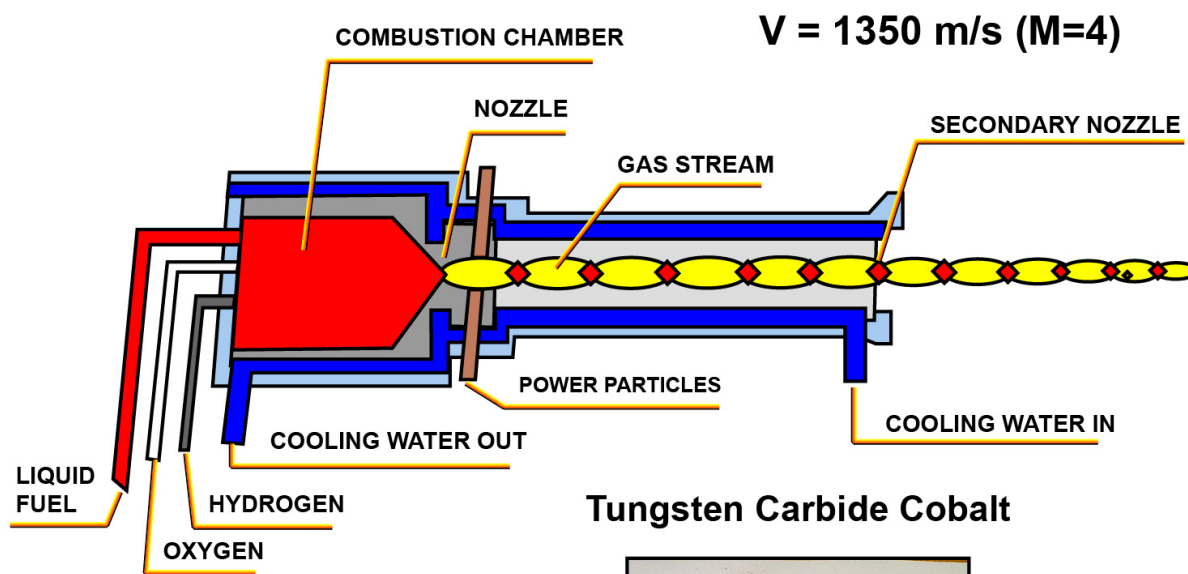
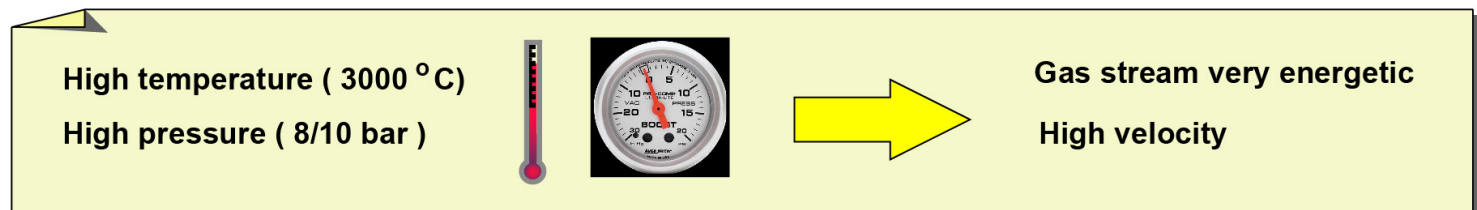
Once the gas stream is produced, it is expanded through a nozzle increasing the gas velocity to around 1350 m/s, which is the equivalent of Mach 4.

At this state powder particles of tungsten carbide-cobalt are injected at high temperature and pressure gas stream. The energy existing in it, is used to melt and accelerate the powder particles through the gun up to a secondary nozzle. The duration of the powder in flame is very low, between 0.5 to 1 millisecond.

As a result of the high energy transferred to the particles, the coating material doesn't need to be fully melted; instead the powder particles, are in a semi-molten state when they impact the surface to treat.

The resulting coating gets a granular fine structure.

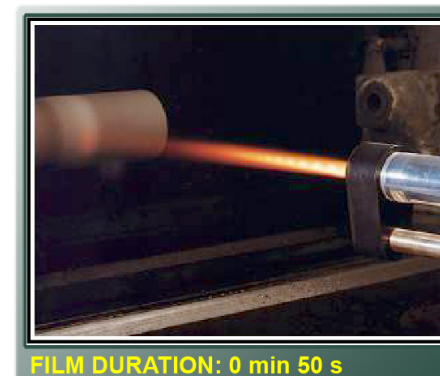
PHYSICAL PRINCIPLE



Tungsten Carbide Cobalt



The particles are in molten state when they impact the surface



Granular fine structure



HIGH VELOCITY OXYGEN FUEL - PHYSICAL PRINCIPLE

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

High Velocity Oxygen Fuel (continued)

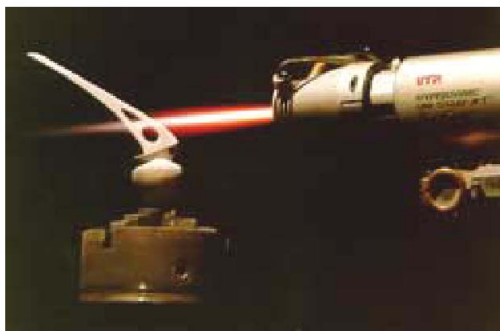
Benefits

The High Velocity Oxygen Fuel is used to replace the hard chrome plating. The HVOF has better performances and resistance to:

- wear
- corrosion
- fatigue
- impact.

This treatment is applied in a simple operation and gives a coating of very low porosity and very good performances: low residual internal stress, very high thickness, density, high adhesion to the substrate and high hardness.

The oxide levels are low, which is acceptable from an environmental point of view. This process also has a low operational cost.


TREATMENT

IMPROVEMENTS IN THE TREATMENT

The HVOF replaces the hard chrome plating used before
It improves its performances and resistance in:

- Wear
- Corrosion
- Fatigue
- Impact


MICROSTRUCTURE

COATING FEATURES

Very low porosity and very high quality in the performances
due to:

- Low residual internal stress
- Very high thickness
- High density
- High adhesion to the substract
- High hardness

Environmental acceptable and low cost operationally

HIGH VELOCITY OXYGEN FUEL - BENEFITS

A380 STRUCTURE: PRESENTATION AND ADVANTAGES

High Velocity Oxygen Fuel (continued)

Application

As an example, on the A380 and A350, the HVOF is used on the landing gear. This process is also used for the surface treatment of flaps, slats, tracks and actuators.

HIGH VELOCITY OXYGEN FUEL

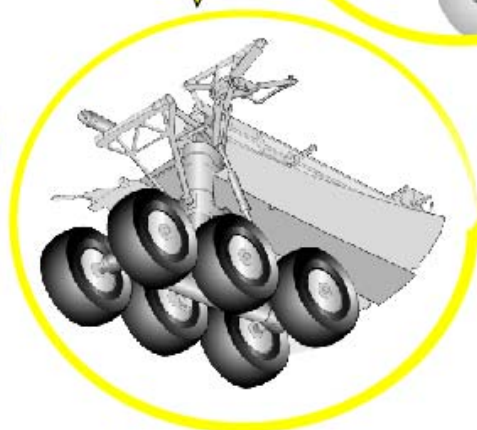
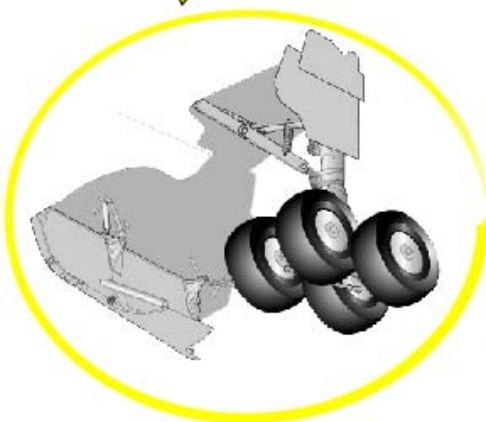
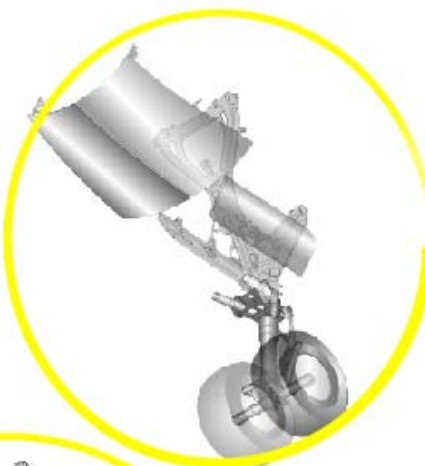
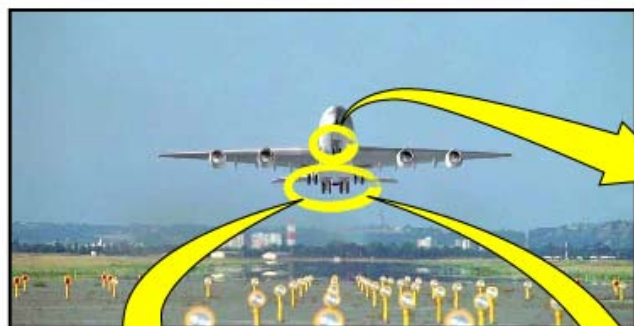
LANDING GEAR

The process is also applied for:

ACTUATORS

FLAPS

SLATS TRACKS



HIGH VELOCITY OXYGEN FUEL - APPLICATION

A380 STRUCTURE: MAINTENANCE ACTIVITIES

GLARE

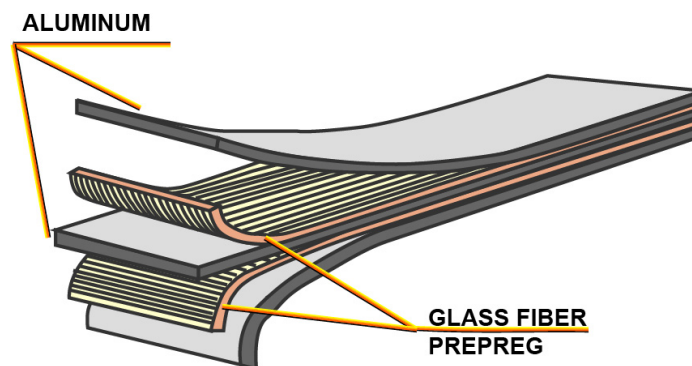
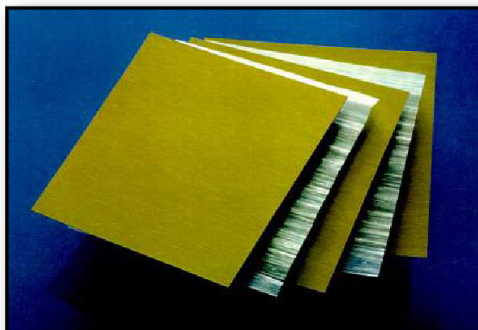
As it has been studied in previous modules, the glare is a new material made of alternative layers of aluminum and glass fiber prepeg.

The most external layer is always aluminum, this circumstance makes that in some aspects the glare behavior is similar to it. Anyway like a laminate, the glare has particular properties, which have influence on the maintenance activities.

This module will present:

- the most important safety requirements necessary to do these maintenances activities,
- the different inspection methods to detect the defaults,
- the possible damage that could be found, and
- the repair solutions in different situations.

GLARE



MODULE OBJECTIVES:



**THE SAFETY REQUIREMENTS TO
DO THE MAINTENANCE ACTIVITIES**



THE INSPECTION METHODS



REPAIR SOLUTIONS



DAMAGE

GLARE

A380 STRUCTURE: MAINTENANCE ACTIVITIES

GLARE (continued)

SAFETY REQUIREMENTS

GLARE and aluminum treatment are similar, so handling GLARE should at least use the same precautions as for aluminum.

It is convenient to collect GLARE waste like dust, chips and scrap sheets, and send them to a special waste.

To prevent damage to the surface, and to mechanical and electrical systems, the area surrounding the repair must have a plastic foil protection held by a masking tape.

Anyway this section exhibits some principles or methods applicable to the listed materials. It will not be updated. Always refer to the applicable and updated document when you work on an aircraft.

Before beginning the inspection it is necessary to make sure that the areas are clean and smooth.

In general the aircraft exterior surfaces are cleaned with methyl ethyl ketone, with an aerosol spray or a hand-wipe.

Use only specified cleaning materials and solutions or equivalents.

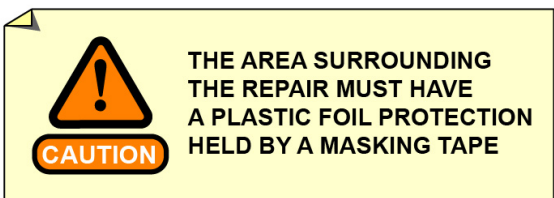
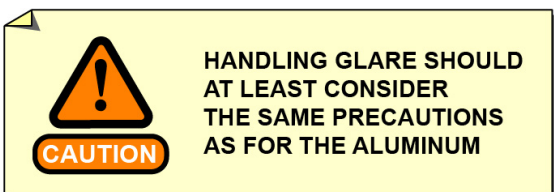
The surface protection could be damaged if unspecified materials are used.

For the health, standard protections or preventive measures like for composites are enough.

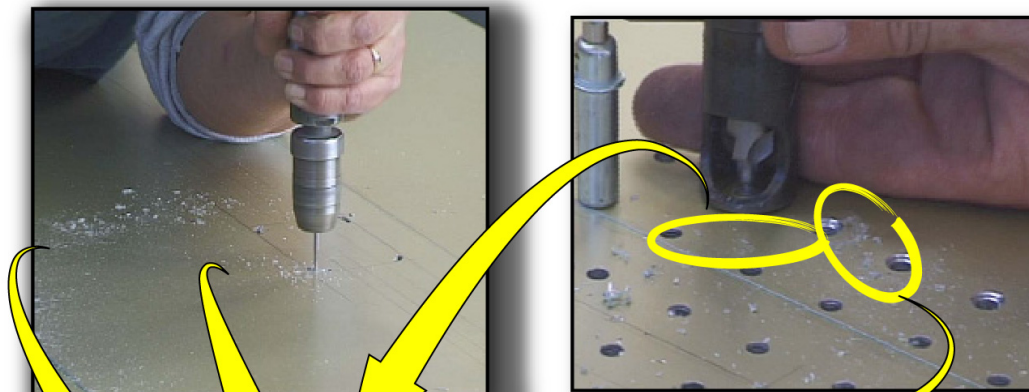
Nevertheless, to make a repair, or to mechanize the glare, protective glasses, clothes and gloves should be worn, to prevent irritation.

Active suction equipments should be used, like a vacuum cleaner to remove dust as much as possible. Do not use air pressure.

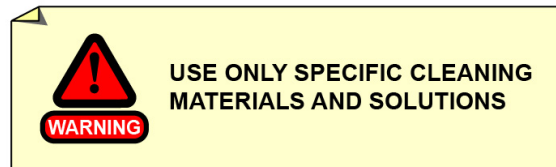
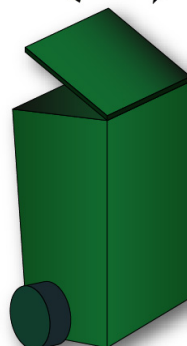
MECHANIZED PRECAUTIONS



REFER TO APPROPRIATE DOCUMENTS AND PROCEDURES



SPECIAL PLACE FOR GLARE WASTE



THE AREA SHOULD BE CLEANED AND SMOOTH

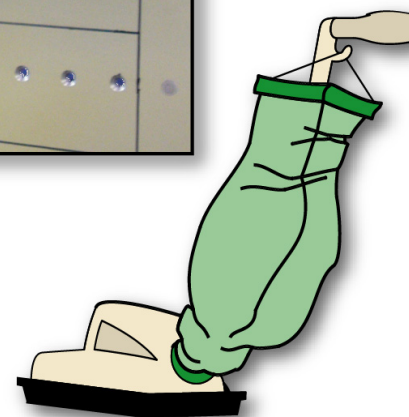
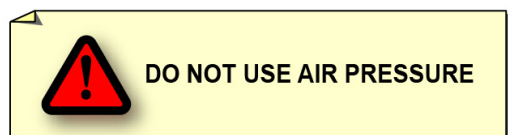
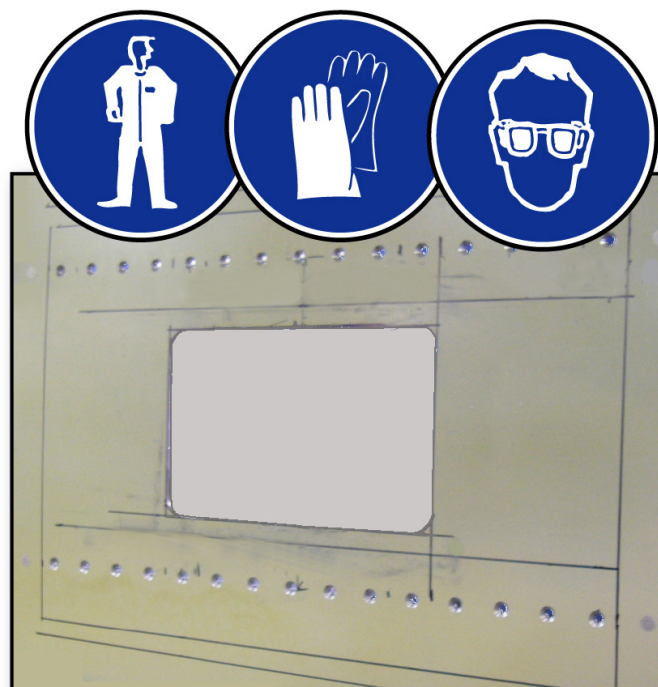


METHYL ETHYL KETONE
USED WITH AN AEROSOL SPRAY
OR A HAND-WIPE

GLARE - SAFETY REQUIREMENTS



**FOR GLARE REPAIR:
SAME SPECIAL PROTECTION
OR PREVENTIVE MEASURES
AS FOR COMPOSITES**



**USE PROPER EQUIPMENT
LIKE A VACUUM CLEANER TO ELIMINATE THE DUST**

GLARE - SAFETY REQUIREMENTS

XN13211 - X04NTT0 - XM51P2NEWTECH01

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A380 STRUCTURE: MAINTENANCE ACTIVITIES

GLARE (continued)

INSPECTION METHODS

During the aircraft lifetime, different kind of damage can occur onto the structure. Any damage has to be inspected, and in any case a damage assessment is required.

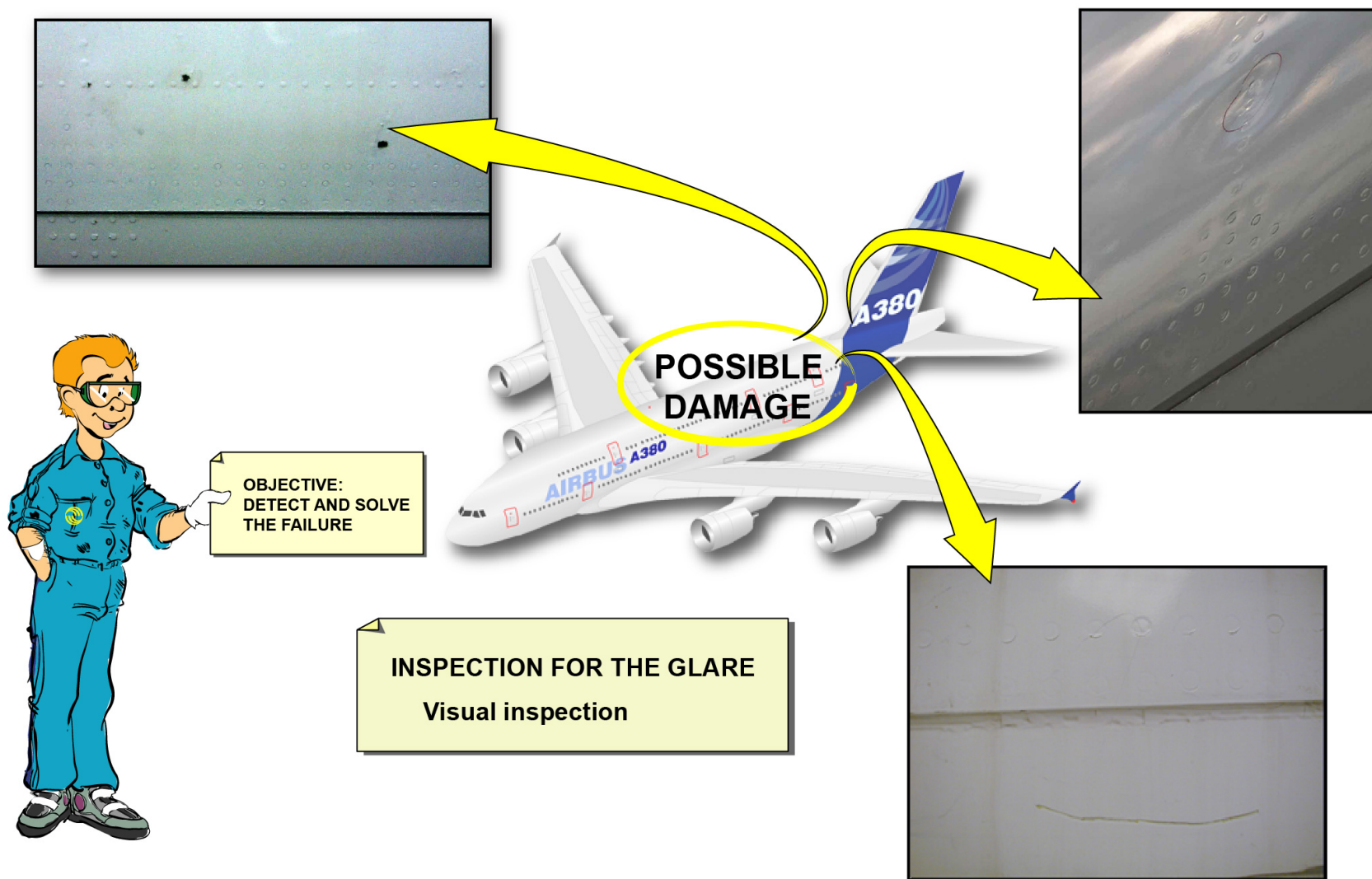
The purpose of all checks scheduled and unscheduled, is to find the better repair solution in case a repair was necessary.

Only visual inspection is used for glare skin panels.

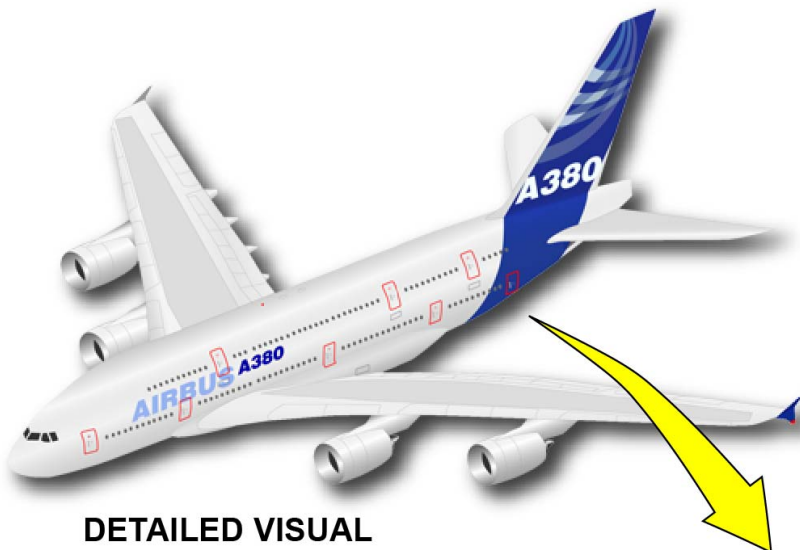
In order to confirm the state of the aircraft structure, it is possible to make a detailed visual inspection.

In this way, it is possible to check the paint and sealant condition and detect corrosion on the surface.

For impact damage, a visual inspection is also sufficient in most cases.



GLARE - INSPECTION METHODS



DETAILED VISUAL INSPECTION



VISUAL INSPECTION

- Confirm the state of the aircraft structure
- Check the paint and sealant condition
- Detect corrosion on the surface
- Detect impact damage

GLARE - INSPECTION METHODS

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A380 STRUCTURE: MAINTENANCE ACTIVITIES

GLARE (continued)

TYPICAL IN-SERVICE DAMAGE

The typical in-service damage expected on the GLARE panels are caused mainly by:

Impact, lightning strike, and corrosion.

These causes lead to different defects such as:

- Bulging,
- cracks in outer aluminum layer,
- or melted outer aluminum layer, which happens in case of lightning strike.

IN-SERVICE TYPICAL DAMAGE

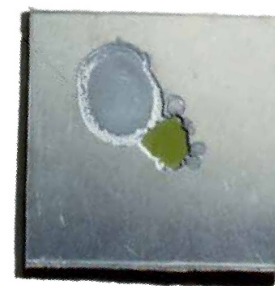
CAUSES:



IMPACT

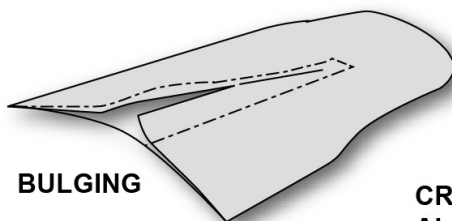


**LIGHTNING
STRIKE**



CORROSION

DAMAGE EFFECTS:



BULGING

**CRACK IN OUTER
ALUMINUM LAYER**



**MELTED OUTER
ALUMINUM LAYER**

GLARE - TYPICAL IN-SERVICE DAMAGE

A380 STRUCTURE: MAINTENANCE ACTIVITIES

GLARE (continued)

DAMAGES

Due to the difficulty of damaging the hard coating generated with this process, the coating damage could coincide with substrate damage.

In the HVOF process, the heat input associated with an incorrect coating application can degrade the strength properties of the substrate, as the heat contained within the particles being deposited is removed by conduction through the structure.

SUBSTRATE DAMAGE

The coating damage could coincide with the substrate damage.

The heat could damage the strength properties.



COATING MICROSTRUCTURE



HVOF GUN



HVOF APPLIED PROCESS

GLARE - DAMAGES

A350 STRUCTURE: COMPOSITE MATERIALS BASICS

SANDWICH AND MONOLITHIC STRUCTURES

General

Composites are used in two principal ways:

- monolithic or laminate structure,
- sandwich structure.

The Monolithic structure is made of layers of fibers and resin only.

The sandwich structure is composed of a core bonded between two monolithic skins.

Facings and core act as one unit because they are bonded together.

Sandwich Structures

These are composite structures formed by introducing a core between two composite laminates, hence the term "sandwich" structure. The core is bonded to the laminates with the use of adhesives, and is usually made of a honeycomb construction or similar. As such, good "through" thickness can be obtained for the composite with significantly lesser weight than a monolithic structure. This yields high bending stiffness (out of plane bending) properties for a significantly lightweight structure.

ADVANTAGES AND DRAWBACKS

Advantages of monolithic structures

- High energy impact for damaging the monolithic area,
- Little fluid ingress problem,
- Bolted repair possible in panels area locations,
- Manufacturing cost.

Advantages of sandwich structures

- Small size of damage on outer skin, easy to detect,
- Good twisting stiffness,
- More versatile concept for access doors fitting,

- Best stiffness versus weight ratio.

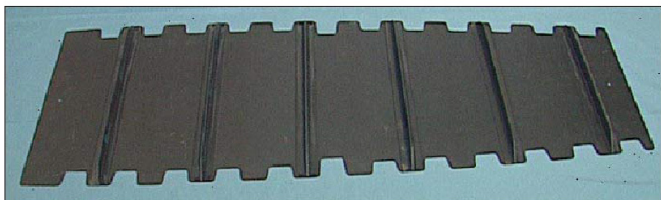
Drawbacks of monolithic structures

- Necessity of internal structure for twisting strength,
- Heavy if compared to sandwich structure.

Drawbacks of sandwich structures

- Fluid ingress after damage,
- Damage with low energy impact,
- Bolted repairs are difficult,
- Manufacturing cost.

MONOLITHIC STRUCTURES



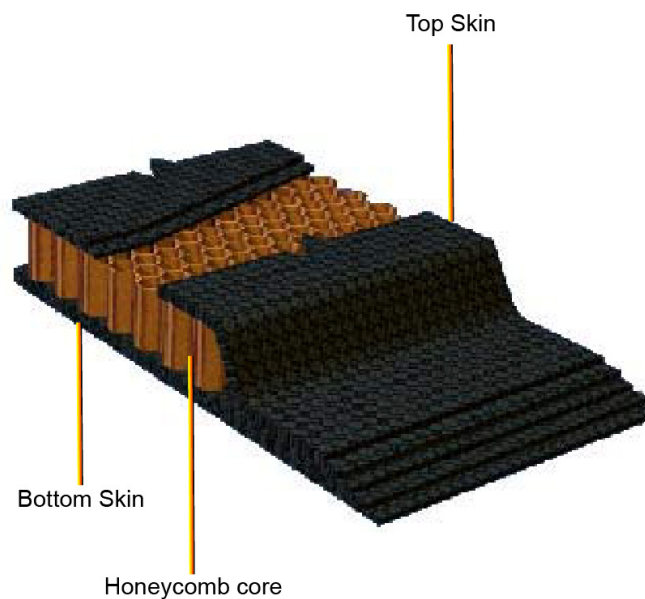
Advantages:

- improved impact resistance over sandwich,
- no fluid ingress problem,
- bolted repair possible in panels area.

Drawbacks:

- heavy if compared to sandwich structure,
- bad stiffness versus weight ratio / sandwich,
- necessity of stiffening structure for twisting and compression resistance.

SANDWICH STRUCTURES



Advantages:

- best stiffness versus weight ratio,
- good twisting stiffness,
- excellent thermal insulation,
- excellent acoustic damping properties.

Drawbacks:

- sensitive to water ingress and various liquid agent,
- impact sensitive compared to monolithic,
- bolted repairs are not recommended.

SANDWICH AND MONOLITHIC STRUCTURES & ADVANTAGES AND DRAWBACKS

A350 STRUCTURE: COMPOSITE MATERIALS BASICS

FIBER MATERIALS

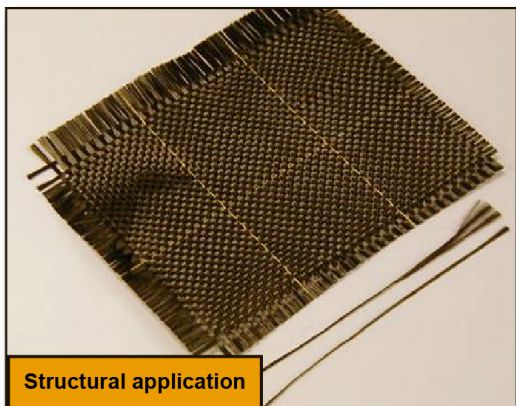
GOALS

Fibers provide a mechanical resistance to the composite material.
Depending on the fiber type, the mechanical properties are strengthdriven or strain-driven.

At Airbus, we basically use four different types of reinforcement, these ones being:

- Carbon Fiber Reinforced Plastic (CFRP),
- Glass Fiber Reinforced Plastic (GFRP),
- Quartz Fiber Reinforced Plastic (QFRP),
- Aramid Fiber Reinforced Plastic (AFRP).

Carbon fibers

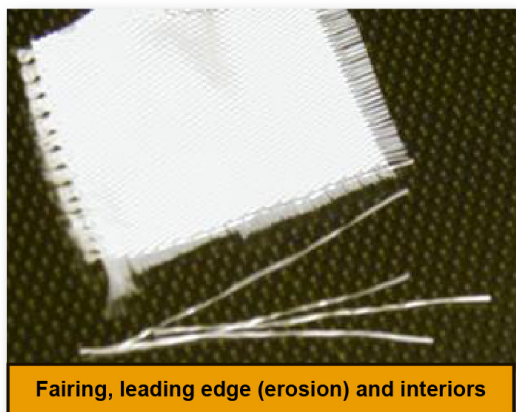


Quartz fibers

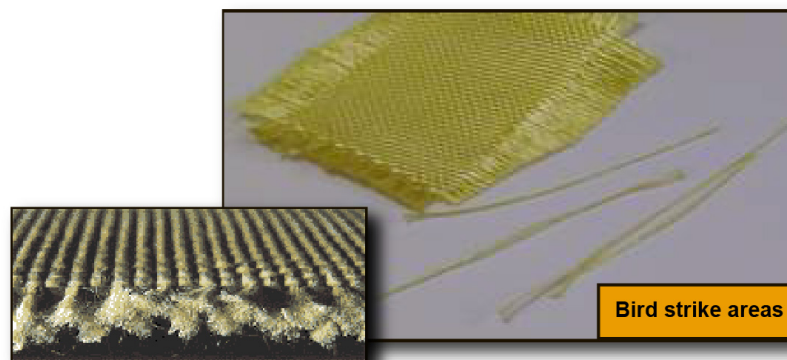


GOALS

Glass fibers



Aramid fibers



FIBER MATERIALS - GOALS

A350 STRUCTURE: COMPOSITE MATERIALS BASICS

FIBER MATERIALS (continued)

TYPICAL PROPERTIES

Carbon:

Carbon is an organic fiber, it has the highest specific stiffness of any commercially available fibers, a very high strength both in tension & compression and a high resistance to corrosion, creep & fatigue.

Impact strength, however, is lower than either glass or aramid. High Modulus (HM) and Ultra High Modulus (UHM) fibers are particularly brittle.

Carbon fibers are electrically conductive.

Strength-driven properties, standard for most load-carrying applications. Based on the 300gsm material, Carbon is currently 4 times the price of glass for the 3K fiber & 3 times the price of glass for 12K.

Glass:

Mineral fiber. By the addition of different constituents at the blending stage, various types of glass fiber can be produced:

E-Glass:

(Electrical), most commonly used, good tensile & compressive strength and stiffness, good electrical properties and relatively low cost, but poor impact resistance. They can be used virtually anywhere, as they exhibit a good resistance to atmospheric corrosion and to most chemicals, as well as excellent dielectric properties.

C-Glass:

(Chemical), excellent chemical resistance.

R, S & T - Glass:

All the manufacturers trade names for the fibers having higher tensile strength and modulus than E-Glass, with a better wet strength

retention. Higher ILSS and wet-out properties due to smaller diameter filaments.

Stiffness: 30% of carbon, strength 60-80%.

The slide shows the typical properties of the main fiber reinforcements most commonly used in the construction of aircraft components.

Quartz:

Quartz is a ceramic fiber, it has a good insulation and excellent mechanical properties up to very high temperatures (1100°C), mechanical properties similar to glass. Its main application is for radomes because of its good radar transparency.

Aramid:

Ballistic-driven properties. A limited use in commercial aircraft (bird strike areas). Being removed from Airbus aircraft. Based on the 300gsm material, Aramid is currently 9 times the price of glass.

Aramid is an organic product. Three grades of Kevlar (brand name from Dupont for Aramid) are mainly available: Kevlar 29, Kevlar 49, and Kevlar 149. The tensile modulus and strength of Kevlar 29 are roughly comparable to the ones of glass (S or E), yet its density is almost half that of glass. Kevlar 49 or 149 can cut the weight even further, if the higher strength is accounted for. Of course, Kevlar's weight savings do come at a price: Kevlar is significantly more expensive than glass.

Aramid fibers exhibit a good chemical resistance and the highest strength-to-weight ratio, however they are weak in compression. They degrade slowly when exposed to UV light.

Kevlar has other advantages, besides weight and strength. Like graphite, it has a slightly negative axial coefficient of thermal expansion, which means Kevlar laminates can be made thermally stable. Unlike graphite, Kevlar is very resistant to impact and abrasion damage. Aramid fibers are recommended where toughness, impact resistance and abrasion resistance are needed.

Kevlar can also be mixed with graphite in hybrid fabrics to provide damage resistance, increased ultimate strains, and to prevent catastrophic failure modes.

Stiffness: 60% of carbon, equivalent tensile strength, poor compression strength.

SUMMARY

Carbon fibers:

- High stiffness and strength to weight ratio.
 - High modulus compared with metallic
- Carbon IM:
- Higher modulus than high strength.
 - Higher cost than HM

Quartz fibers:

- Good radar transparency property
- Good mechanical properties at high temperature

Glass fibers:

- High strength/weight ratio
- Dielectric property
- Corrosion resistant

Aramid fibers:

- Impact damage resistant
- Difficult to machine
- Weak in compression

FIBER MATERIALS - TYPICAL PROPERTIES

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A350 STRUCTURE: COMPOSITE AWARENESS

COMPOSITE MATERIALS

Main materials

The composite materials used in Aircraft industry are a combination of two materials: Fiber and Resin (matrix).

Type of Fibers:

- Carbon
- Glass
- Aramid
- Quartz

Type of Resin:

- Epoxy
- Phenolic
- Polyphenylsulfide

Various types of fibers have been developed, for various purposes.

Design will decide on the best couple fiber + resin.

Structure type

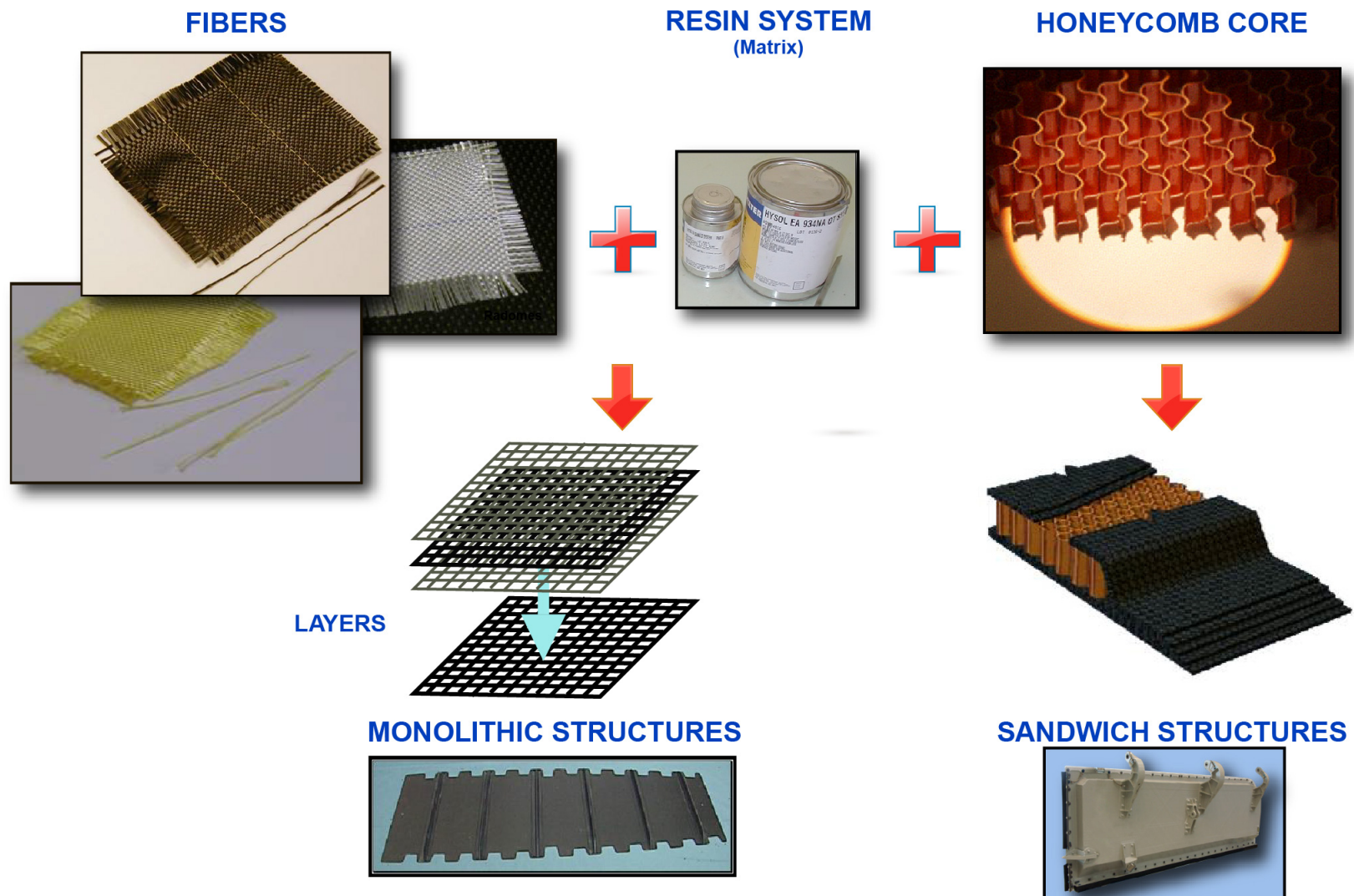
Composites are used in two principal ways:

- monolithic or laminate structure,
- sandwich structure.

The Monolithic structure is made of layers of fibers and resin only.

The sandwich structure is composed of a core bonded between two monolithic skins.

Facings and core are bonded together and act as one.



COMPOSITE MATERIALS - MAIN MATERIALS & STRUCTURE TYPE

A350 STRUCTURE: COMPOSITE AWARENESS

COMPOSITE MATERIALS (continued)

Aircraft environmental aggressions

Damage on aircraft can be due:

- either to environmental aggressions such as rain, hail, high temperature/cold temperature, lightning strike, bird impact.
- or due to maintenance activities such as ground handling, drop of tools and fluids during maintenance tasks.

On composite structures, impact damage due to hail, bird impact or maintenance activities may lead to:

Delamination (between plies),

Disbonding (between plies and honeycomb core for a sandwich part),

A combination of delaminations and cracks.

Overheat or too cold temperature in combination with moisture may lead to:

Resin degradation,

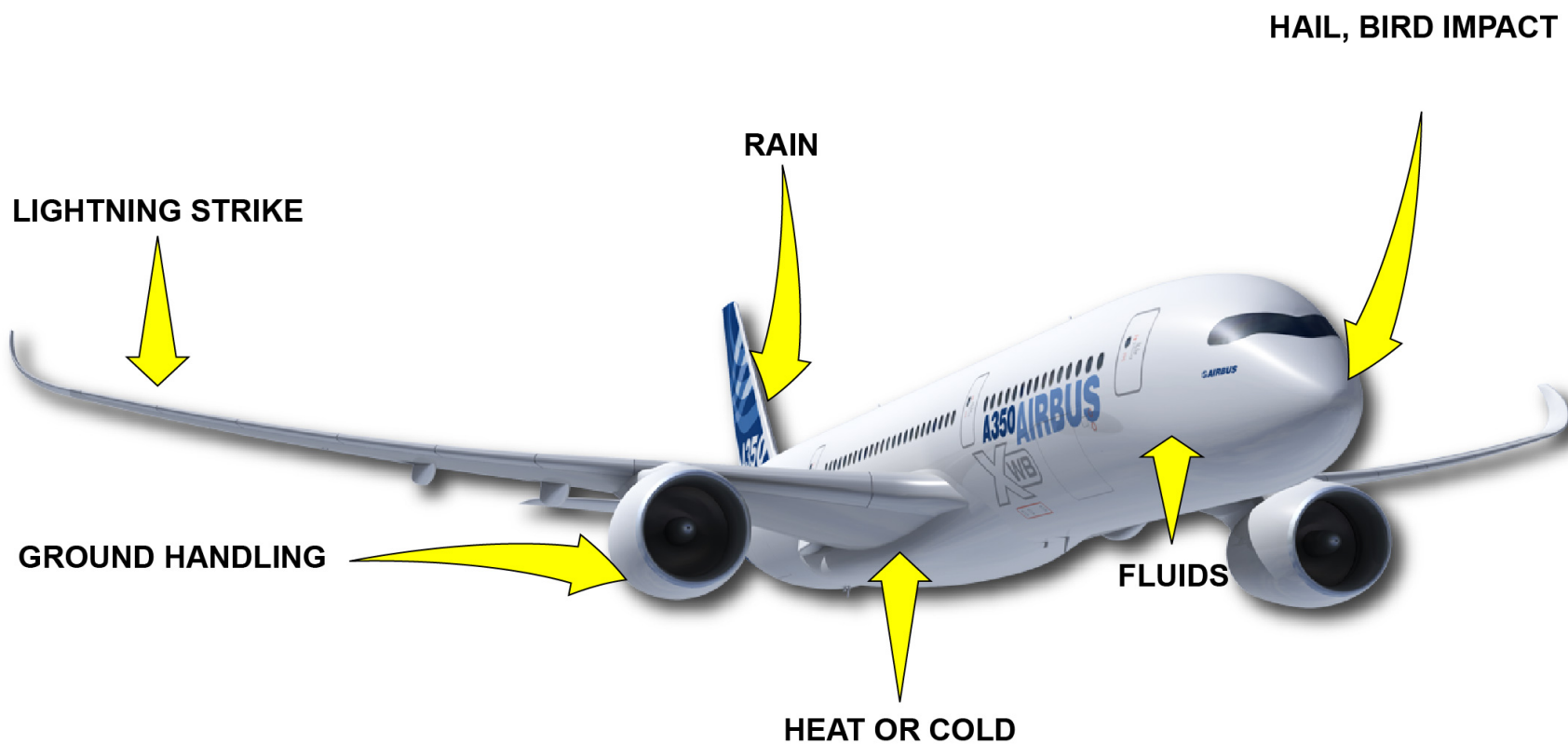
In case of overheated area, discoloration of paint and burnt area.

Micro-cracking due to thermal cycling.

Rain on the leading edge areas may lead to erosion and further to galvanic corrosion. Fluids contamination may degrade the resin and may affect the mechanical properties of the structure.

Lightning strike may lead to:

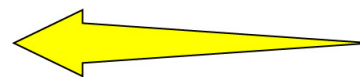
- puncture, burnt part, holes, arking damaging systems and metallic objects.



COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

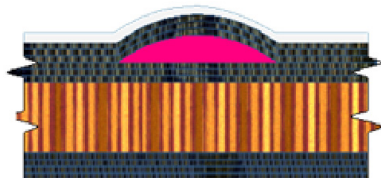
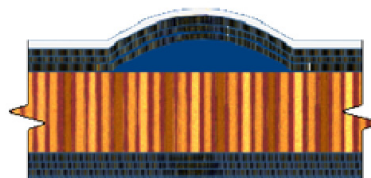
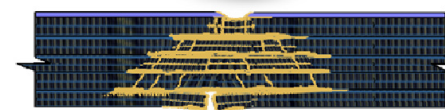

HAIL EFFECT ON A RADOME

HAIL, BIRD IMPACT
POSSIBLE IMPACT DAMAGE
(IN FLIGHT OR ON GROUND)



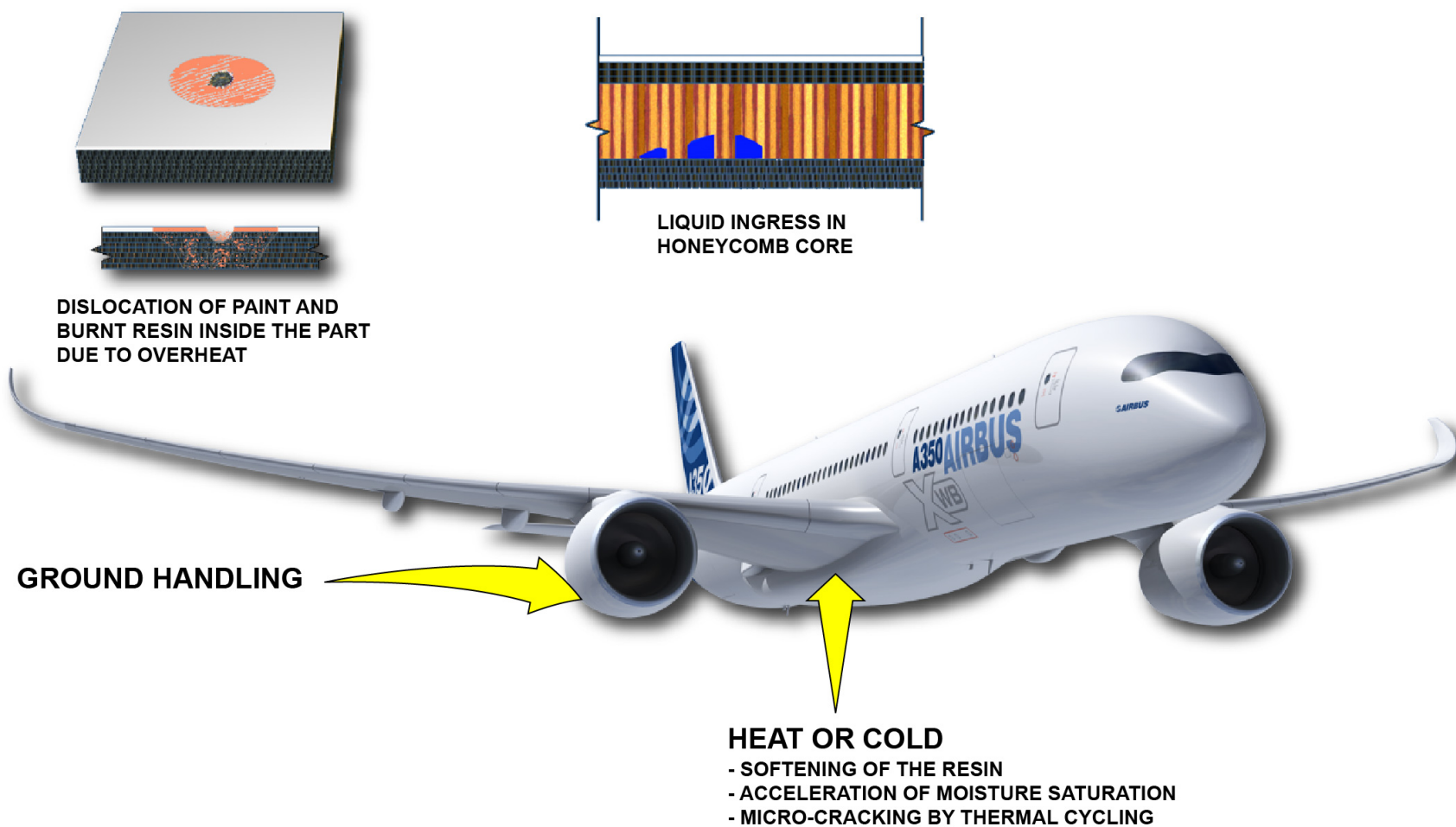
GROUND HANDLING

- COLLISION WITH GROUND EQUIPMENT
- IMPACTS DURING SERVICE


DELAMINATION

DEBONDING


FIR-TREE EFFECT:
DELAMINATION AND CRACKS
BETWEEN PLIES

COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS



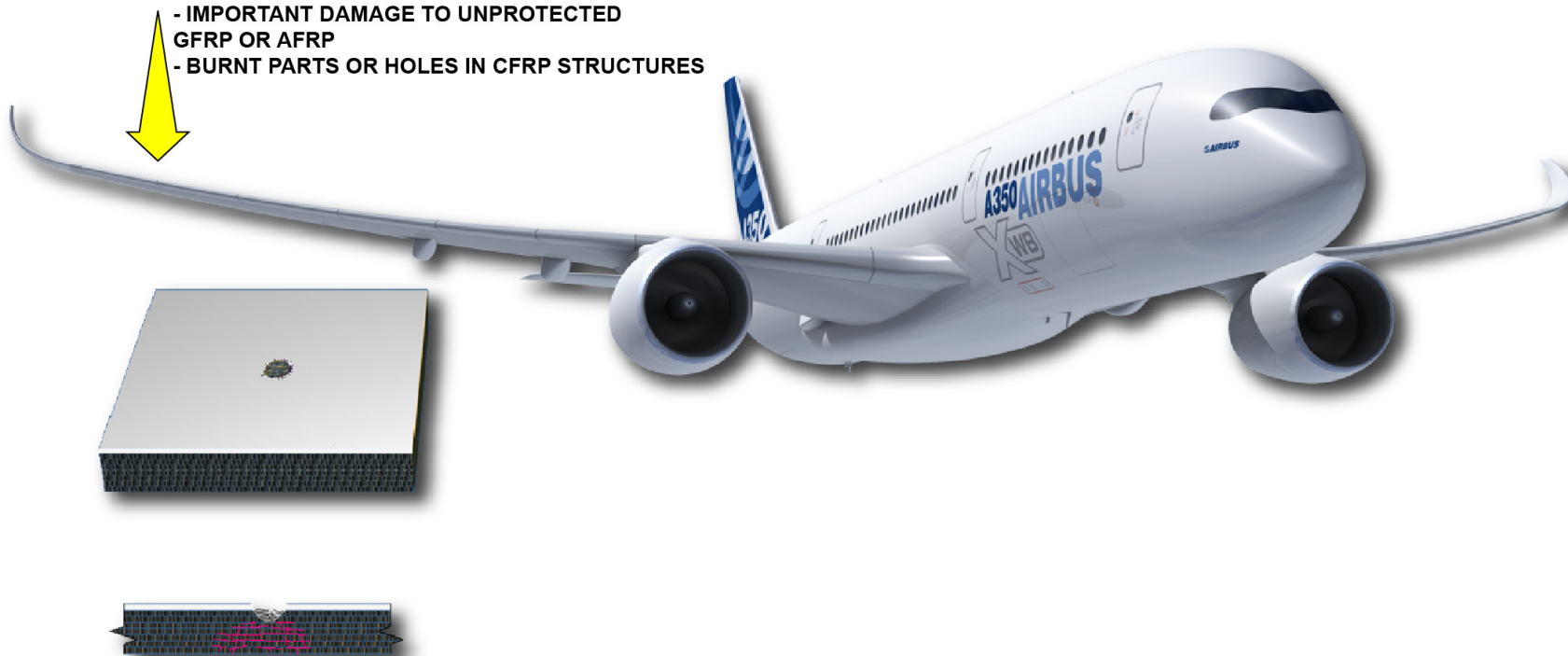
COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS



COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

LIGHTNING STRIKE

- IMPORTANT DAMAGE TO UNPROTECTED GFRP OR AFRP
- BURNT PARTS OR HOLES IN CFRP STRUCTURES


COMPOSITE MATERIALS - AIRCRAFT ENVIRONMENTAL AGGRESSIONS

A350 STRUCTURE: ELECTRICAL STRUCTURE NETWORK (ESN)

ESN and MBN

The use of carbon fibre reinforced plastic (CFRP) material requires solutions to provide electrical functions due to the low electrical conductivity of the CFRP compared to metal.

The solutions are the Metallic Bonding Network (MBN) and the Electrical Structure Network (ESN).

The Metallic Bonding Network (in unpressurized areas) provides:

- Lightning strikes protection

- Electrostatic protection

- Electrical a current path (bonding)

- Connection to the earth when the A/C is on the ground

The Electrical Structural Network(in pressurized fuselage) provides:

- Lightning strikes protection

- Electrostatic protection

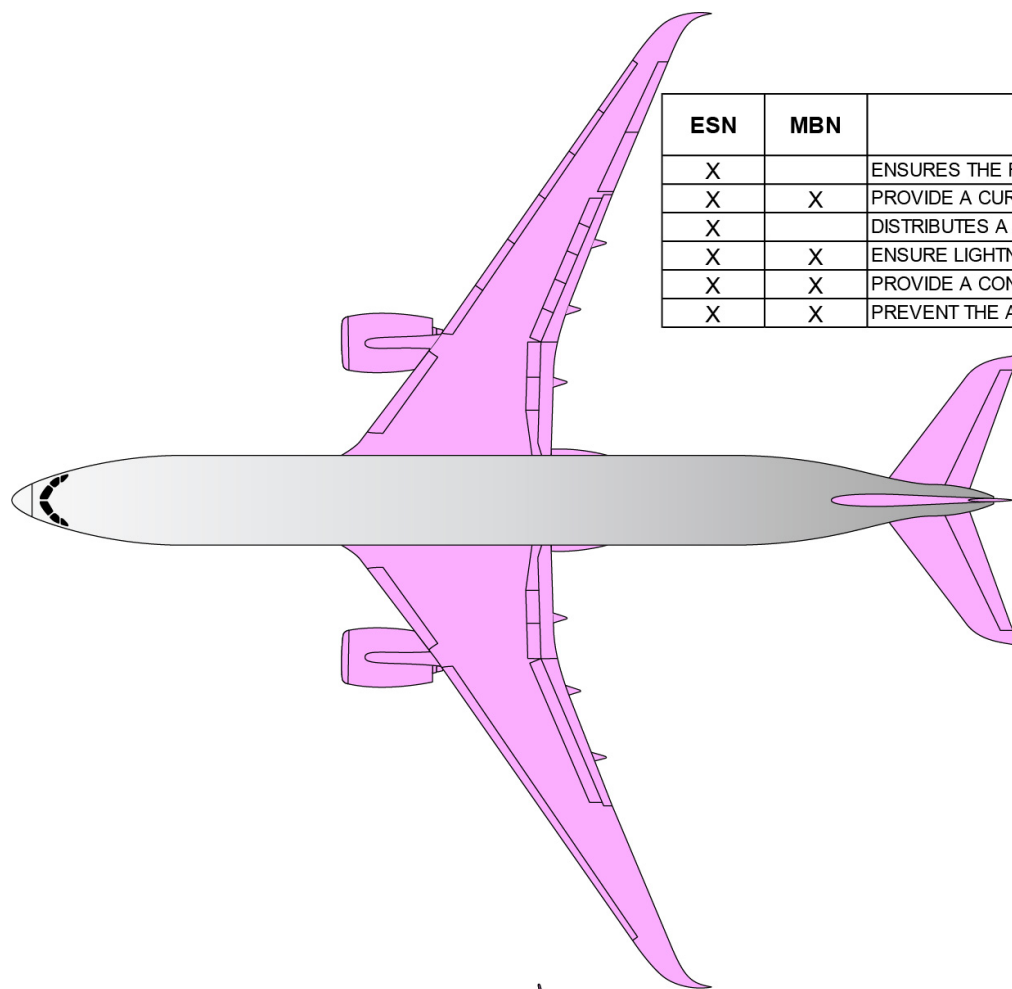
- Electrical current path (bonding)

- Connection to the earth when the A/C is on the ground

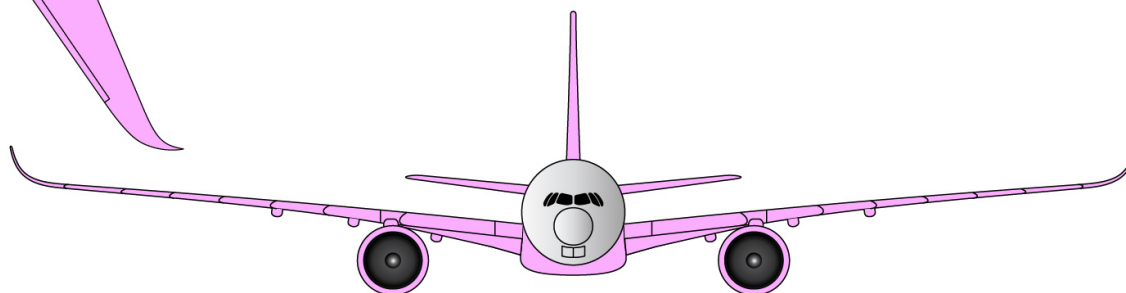
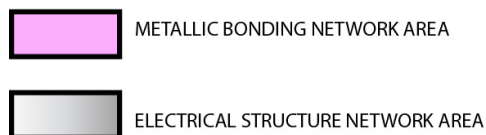
- Electrical current return signal (grounding)

Provision of common point of voltage reference for all electrical components.

The ESN and MBN are mechanically connected together.



ESN	MBN	FUNCTION
X		ENSURES THE FUNCTIONAL CURRENT RETURN (GROUNDING)
X	X	PROVIDE A CURRENT PATH FOR FAULT CURRENT AND ELECTROSTATIC CURRENT (BONDING)
X		DISTRIBUTES A COMMON VOLTAGE REFERENCE
X	X	ENSURE LIGHTNING STRIKE PROTECTION
X	X	PROVIDE A CONNECTION TO THE EARTH WHEN THE A/C IS ON GROUND
X	X	PREVENT THE ACCUMULATION AND EVACUATE THE STATIC ELECTRICITY

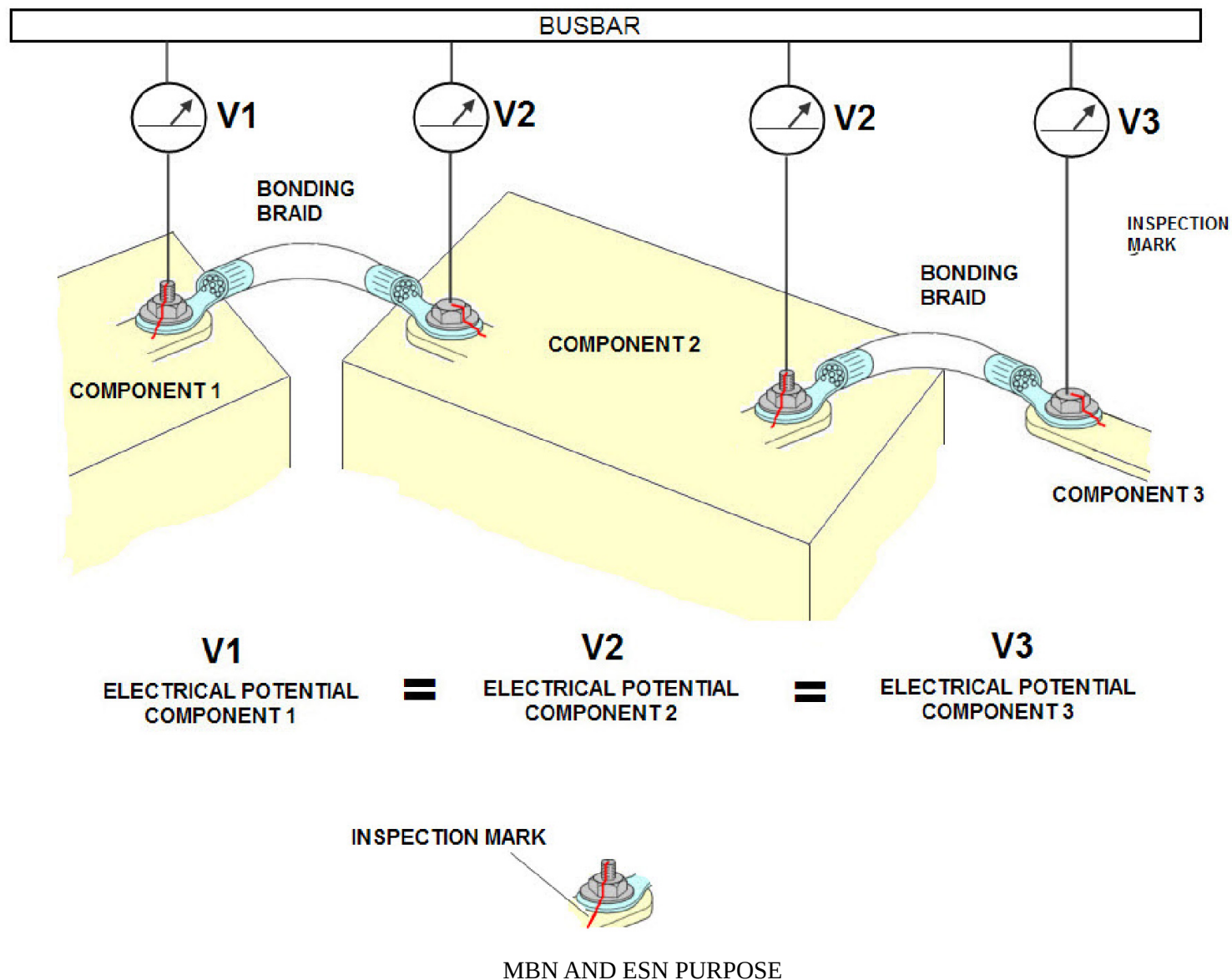


ESN AND MBN

A350 STRUCTURE: ELECTRICAL STRUCTURE NETWORK (ESN)

MBN and ESN Purpose

The Metallic Bonding Network (MBN) is a network of metallic parts, electrically bonded together. It consists of metallic parts of the primary structure as well as connecting parts, like metallic strips and bonding jumpers. The MBN runs through the whole fuselage including wings, horizontal and vertical tail plane and is not isolated from CFRP structures. It is used for electrical bonding purposes, such as failure current return, lightning protection and electrostatic discharge.



A350 STRUCTURE: ELECTRICAL STRUCTURE NETWORK (ESN)

MBN and ESN Purpose (continued)

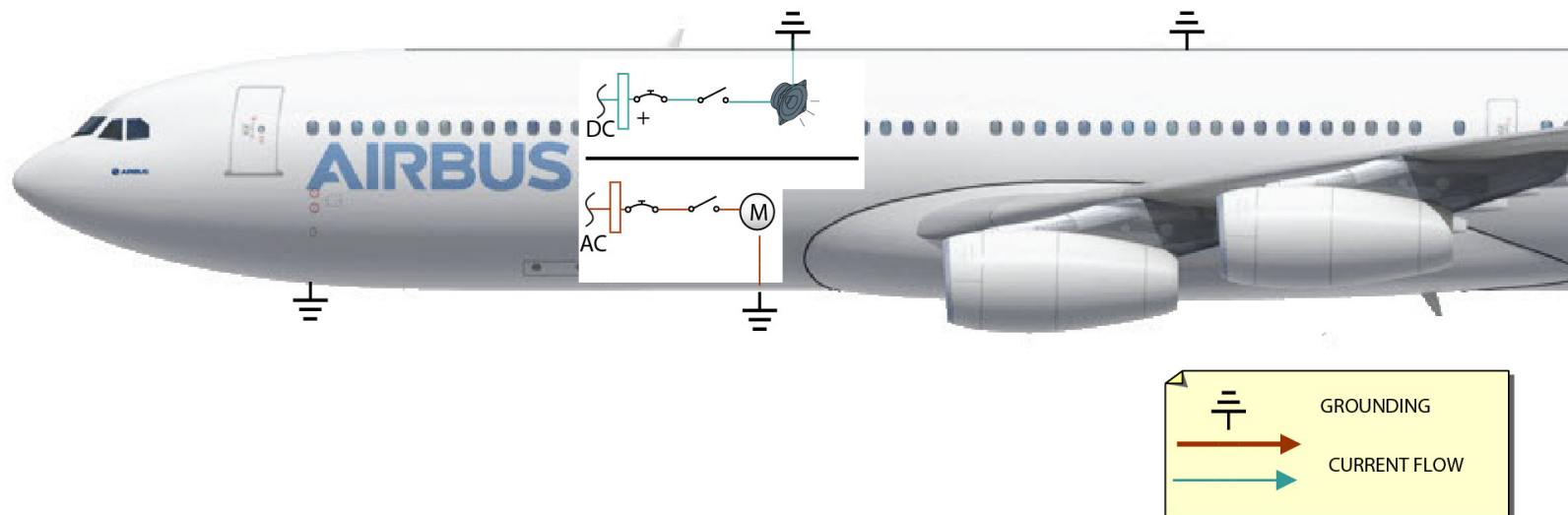
MBN

A conventional aircraft fuselage inherently provides electrical functions such as grounding, bonding, voltage reference and protection from electromagnetic hazards. This is mainly provided by the metallic structural frames, stringers and skin panels.

All AC or DC electrical source, supplies power through bus bars on which are connected electrical equipment. Functional current return is provided by conductive metallic structural components connected and attached to the A/C structure.



METALLIC STRUCTURE



MBN AND ESN PURPOSE - MBN

A350 STRUCTURE: ELECTRICAL STRUCTURE NETWORK (ESN)

MBN and ESN Purpose (continued)

ESN

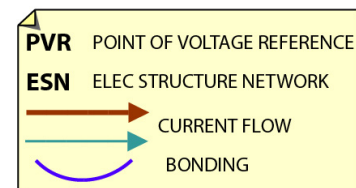
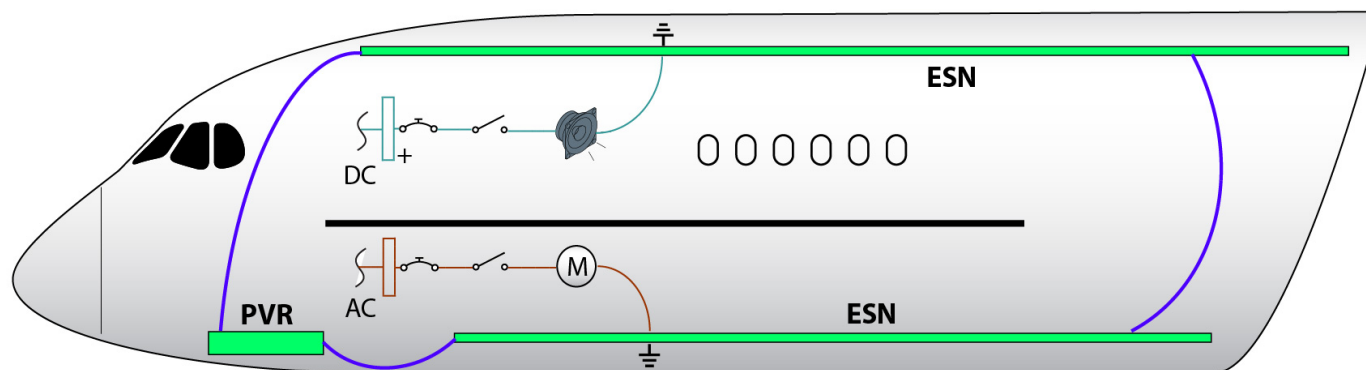
Due to the low conductivity characteristics of the CFRP, a metallic network is installed inside the A/C. This is called the Electrical Structure Network (ESN).

The ESN is a metallic structure used as common current return for all circuits inside the pressurized fuselage and as voltage reference for discrete signals. Additionally it is used for bonding and as connection to the ground.

All ESN parts also contribute to the lightning protection.

The Point of Voltage Reference (PVR) is the power supply voltage reference. All the AC and DC source neutral shall be connected to the PVR. All functional and power current shall return to the PVR through the ESN or dedicated wire.

The PVR is located in the avionics bay and is made of metallic elements.



MBN AND ESN PURPOSE - ESN



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